4.0. PREDICTING FUTURE WAVE CLIMATE WITH PROJECTS

In Step G (LADNR 1998g) the future without project wave climate in Areas 1, 2 and 3, shown in Figure 4-1, was quantified through numerical wave modeling. These findings demonstrate substantial increases in wave energy levels in all of the major bays in the study area within both the 30- and 100-year forecasts. This section reviews the impacts on the wave climate of implementing the two alternatives developed in Step I (LADNR 1998i). A primary assumption is that waves cause erosion along the inner bay shoreline. Using information from the numerical modeling, land loss rates in these areas were adjusted where substantial changes in wave energy occur. This methodology and effects of these changes on the marsh shoreline are discussed in Section 5.0. The primary objective of this section is to determine the effects Alternatives 1 and 2 play in wave processes, particularly wave energy distribution in the bays.

4.1. No-Action

Under no-action, all changes in wave height--primarily increases--are due to the transformation of the subaerial mass of the barrier islands and mainland beaches (e.g., Caminada-Moreau headland) to subaqueous shoals or deepening of the offshore profile. Forecasted wave heights for present, 30- and 100-years are shown in Figures 4-2 to 4-10. In each model run, the marsh shoreline configuration remained constant for each time period.

In general, the present barrier shoreline provides substantial protection in reducing wave height. This is especially true for areas immediately landward of the barriers. The no-action model runs demonstrate that the present degraded barrier islands have a substantial influence on blocking the Gulf waves from entering the back-barrier bays and impacting the marsh shorelines. The future loss of the barrier shoreline results in substantial increases in wave energy in Terrebonne Bay, Lake Pelto and Caillou Bay.

The changes in wave height, due to no-action, in 30- and 100-years compared to present conditions are shown in Figures 4-11 to 4-16.

Figure 4-1. Base Map of Phase 1 Study Area, Louisiana Barrier Island Study.

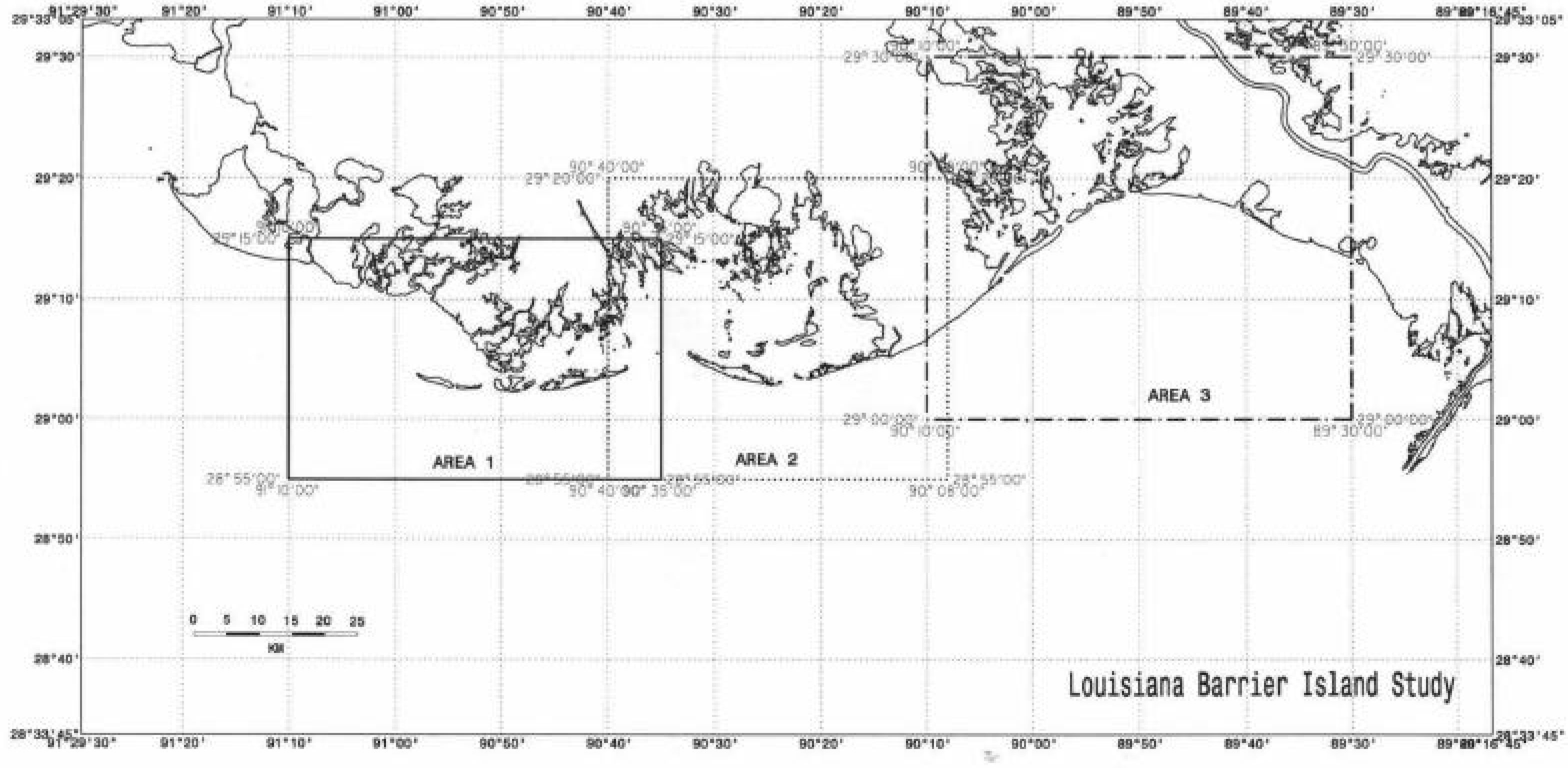


Figure 4-2. Simulated Wave Height for the Present Scenario During Fair Weather Wave Conditons - Area 1

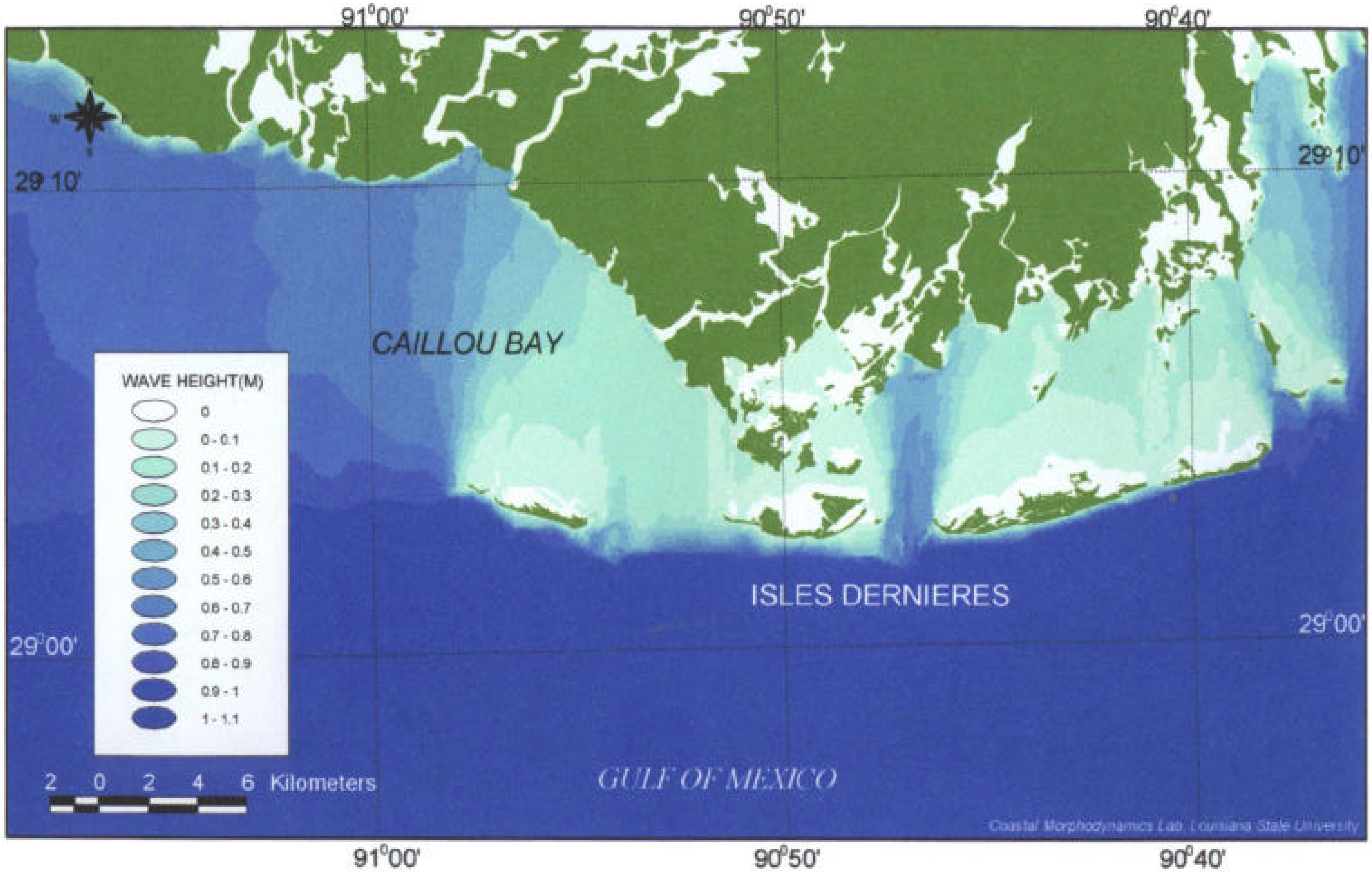


Figure 4-3. Predicted Wave Height for the 30-Year Projection During Fair Weather Conditions - Area 1

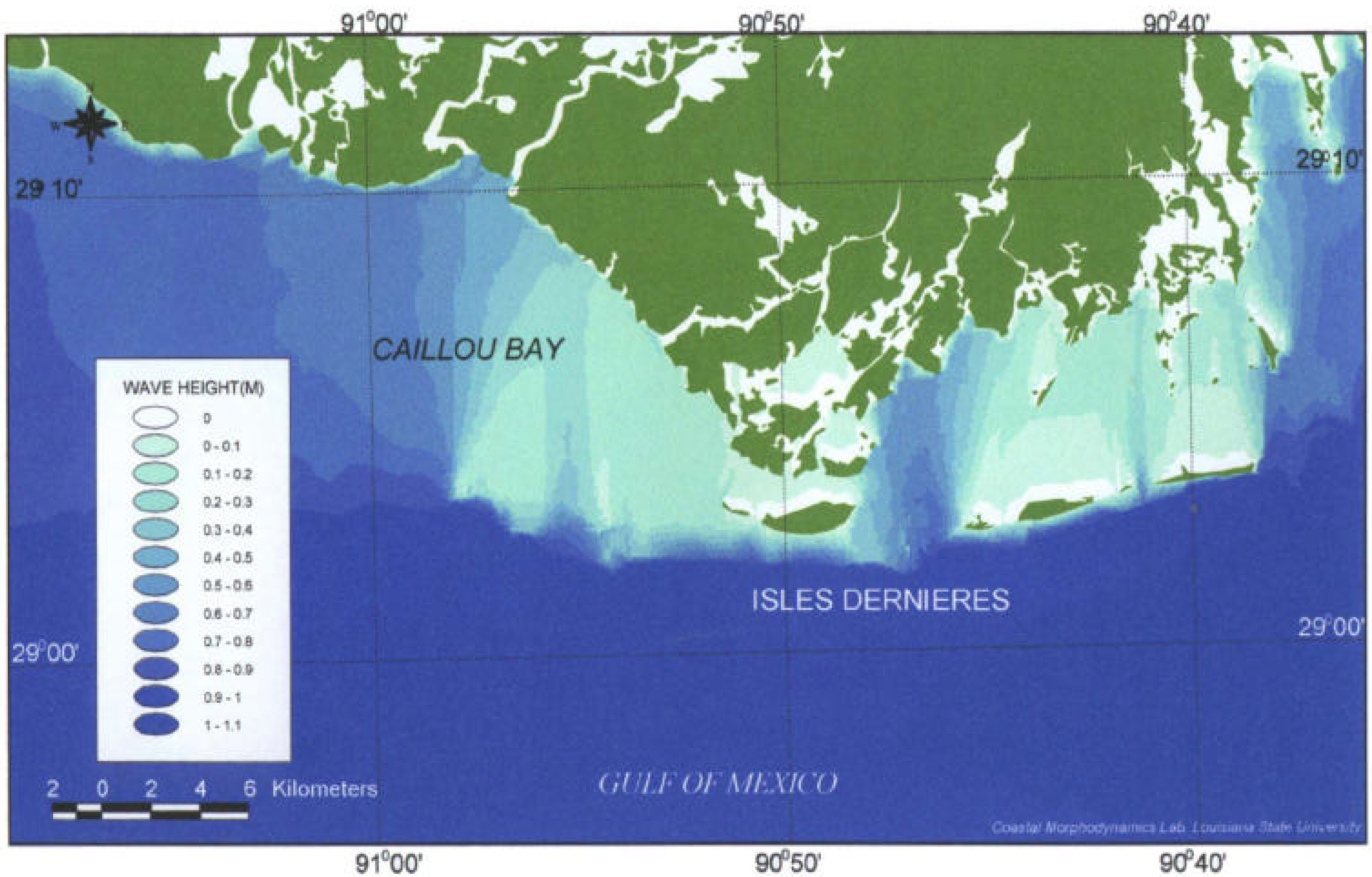


Figure 4-4. Predicted Wave Height for the 100-Year Projection During Fair Weather Wave Conditions - Area 1

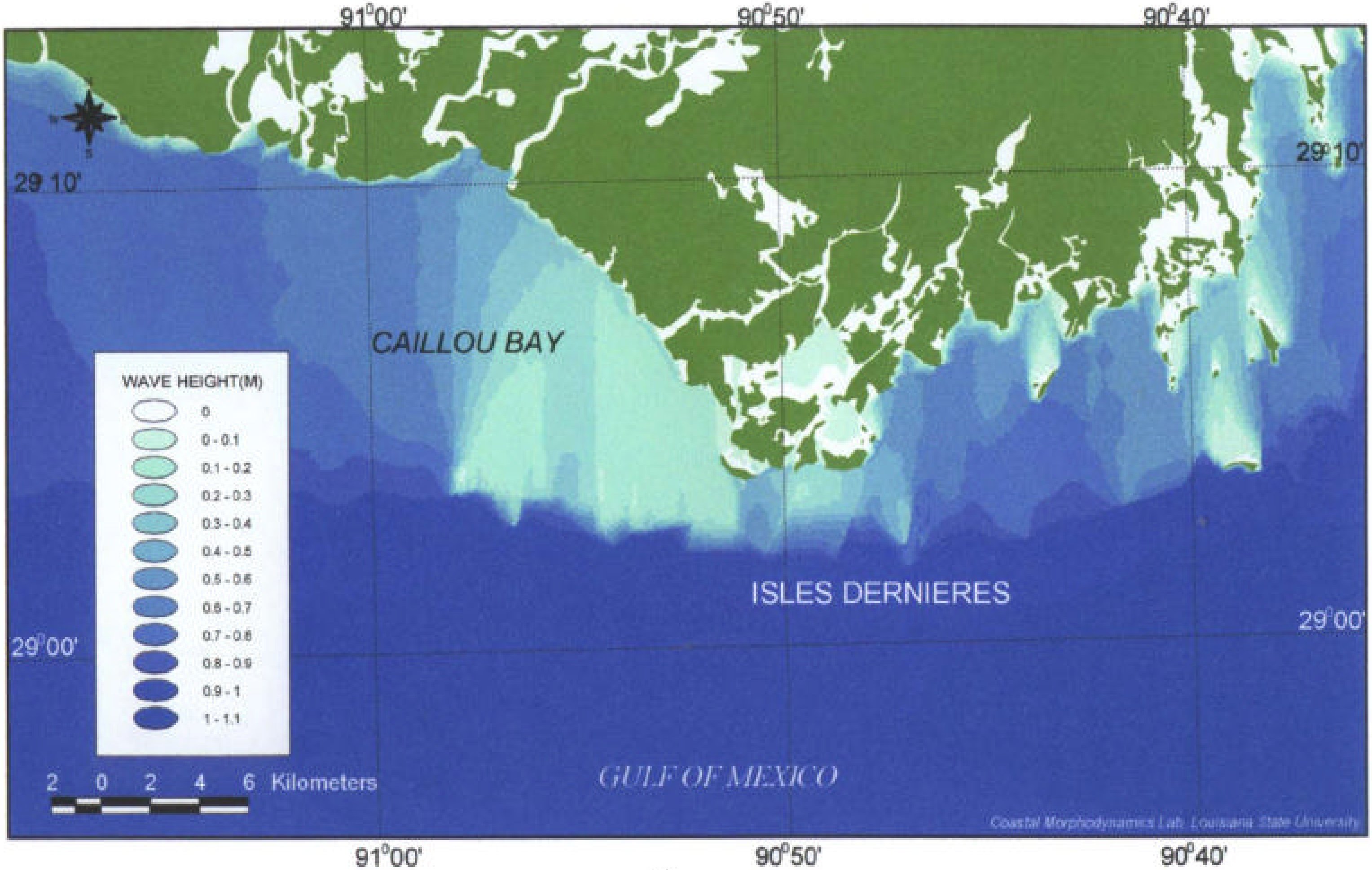


Figure 4-5. Simulated Wave Height for the Present Scenario During Fair Weather Wave Conditions - Area 2

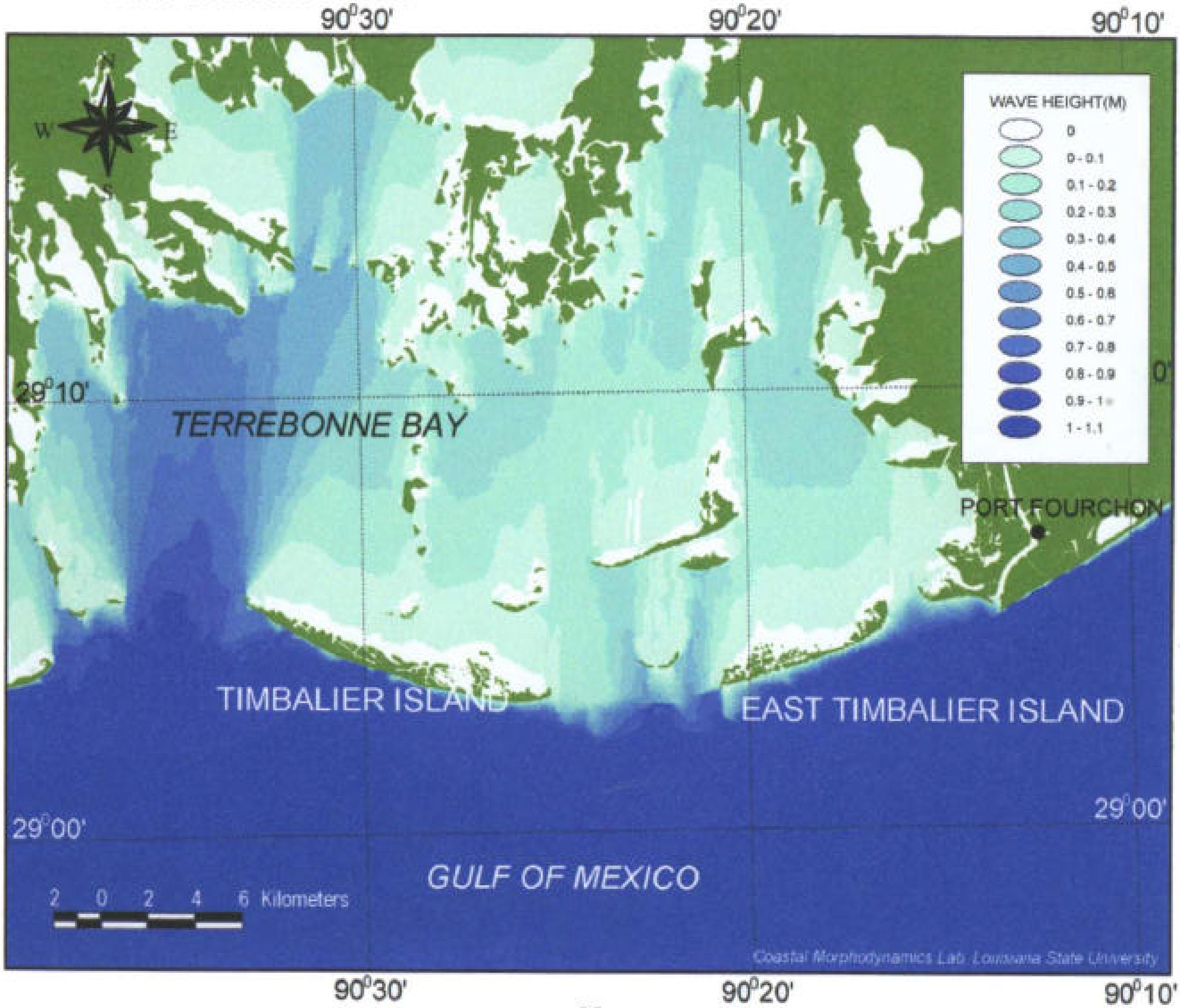


Figure 4-6. Predicted Wave Height for the 30-Year Projection During Fair Weather Wave Conditions - Area 2

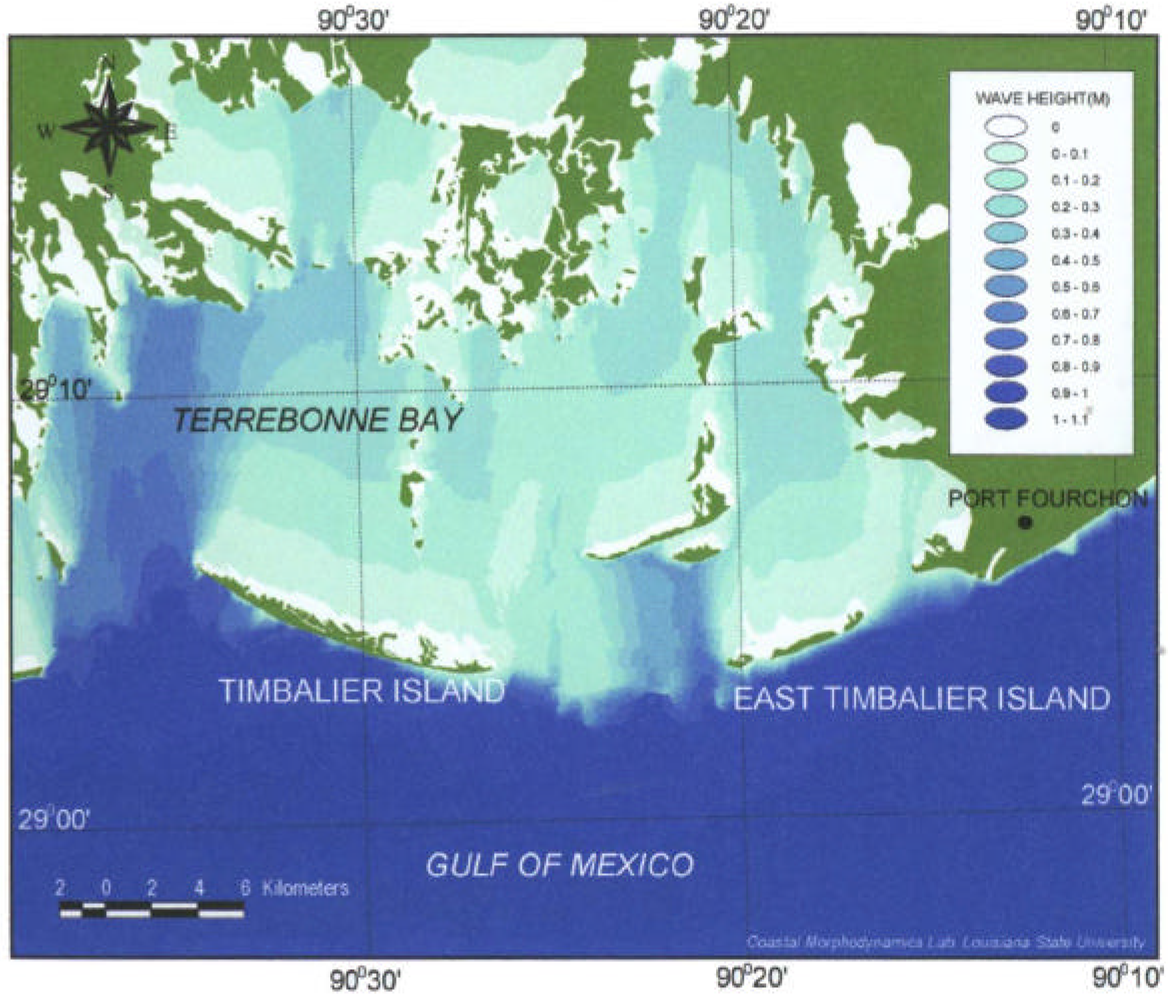


Figure 4-7. Predicted Wave Height for the 100-Year Projection During Fair Weather Wave Conditions - Area 2

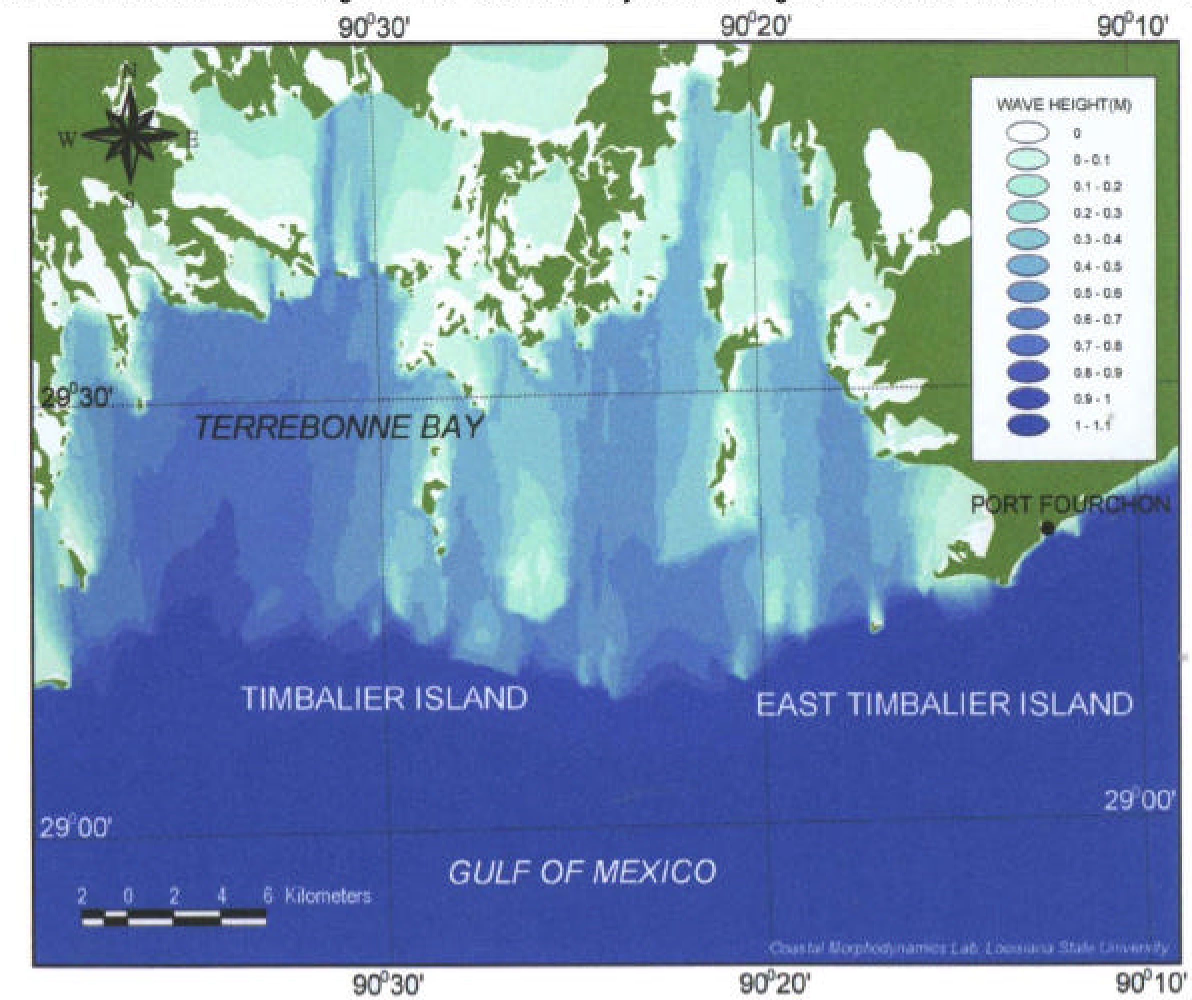


Figure 4-8. Simulated Wave Height for the Present Scenario During Fair Weather Wave Conditions - Area 3

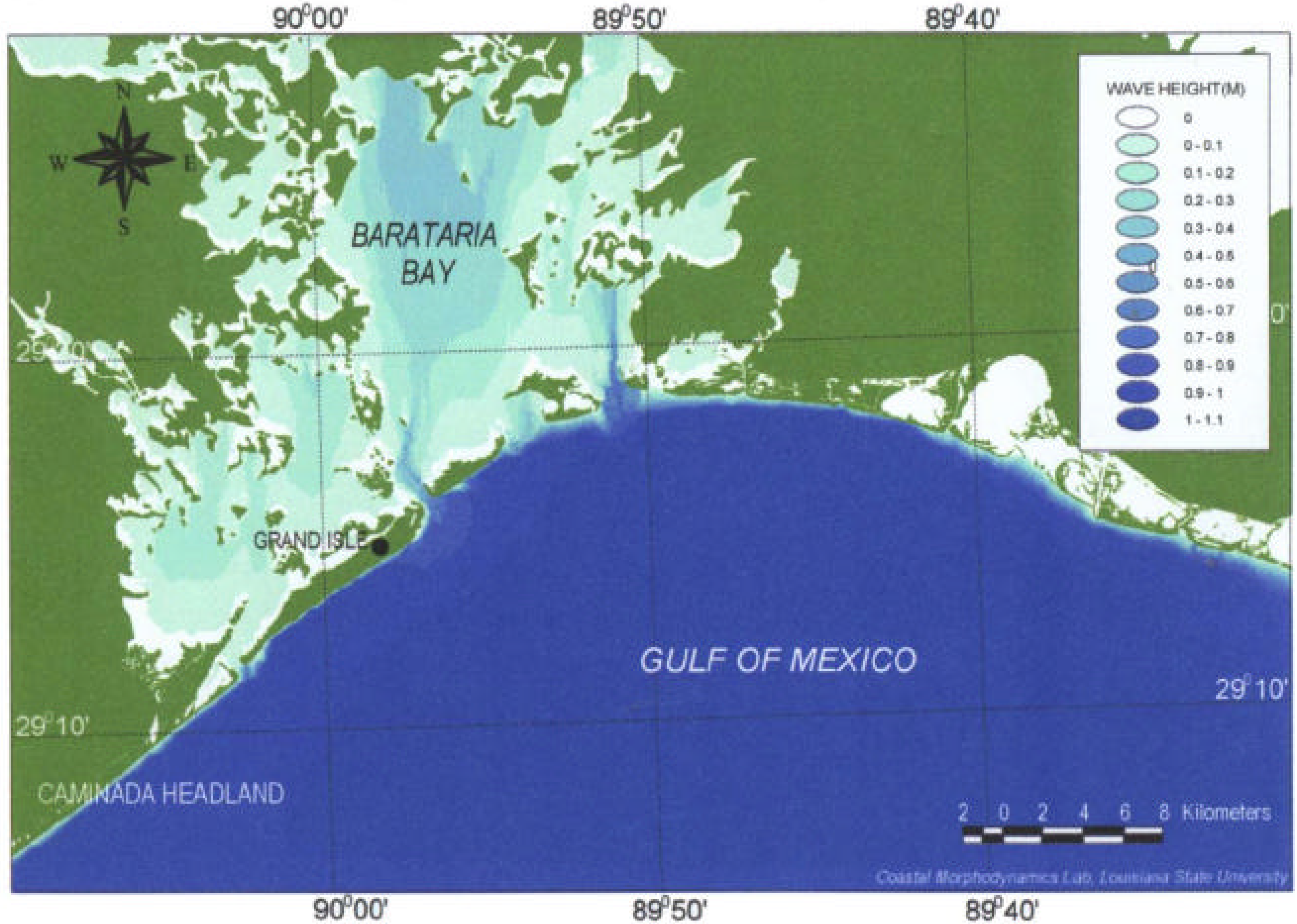


Figure 4-9. Predicted Wave Height for the 30-Year Projection During Fair Weather Wave Conditions - Area 3

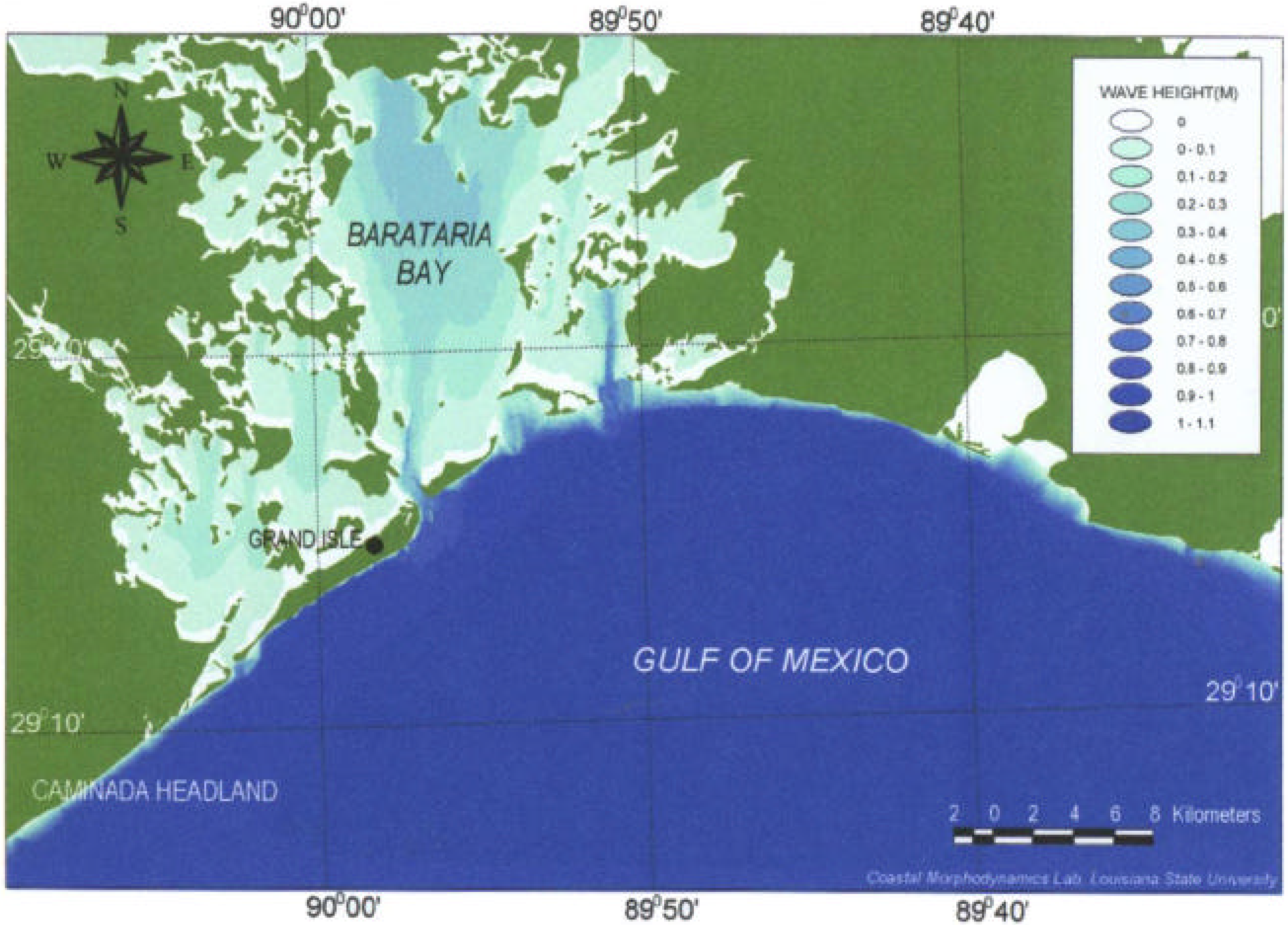


Figure 4-10. Predicted Wave Height for the 100-Year Projection During Fair Weather Wave Conditions - Area 3

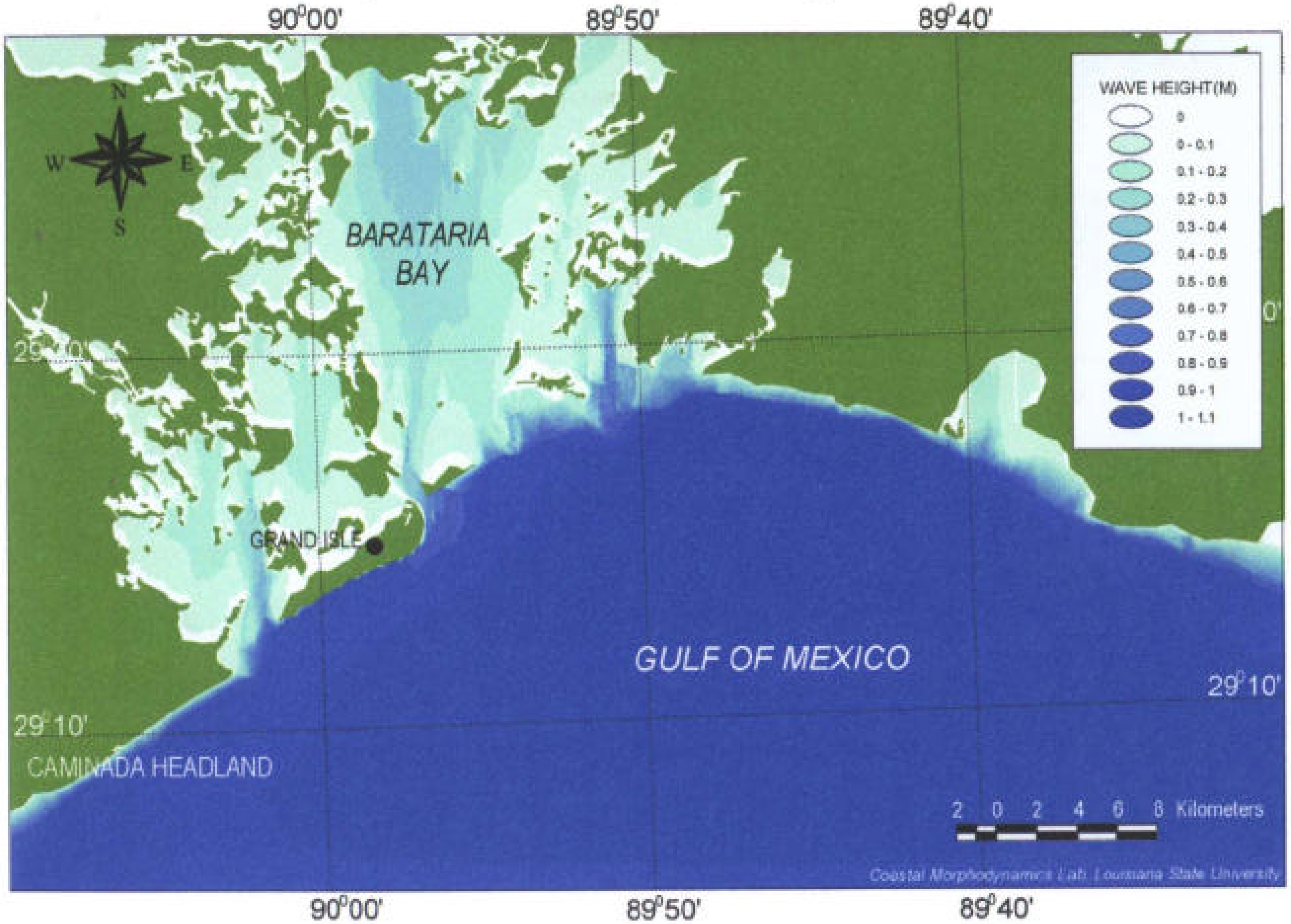


Figure 4-11. Predicted Change in Wave Height for the 30-Year Projection in the Event of Barrier Island Erosion For Fair Weather Wave Conditions - Area 1

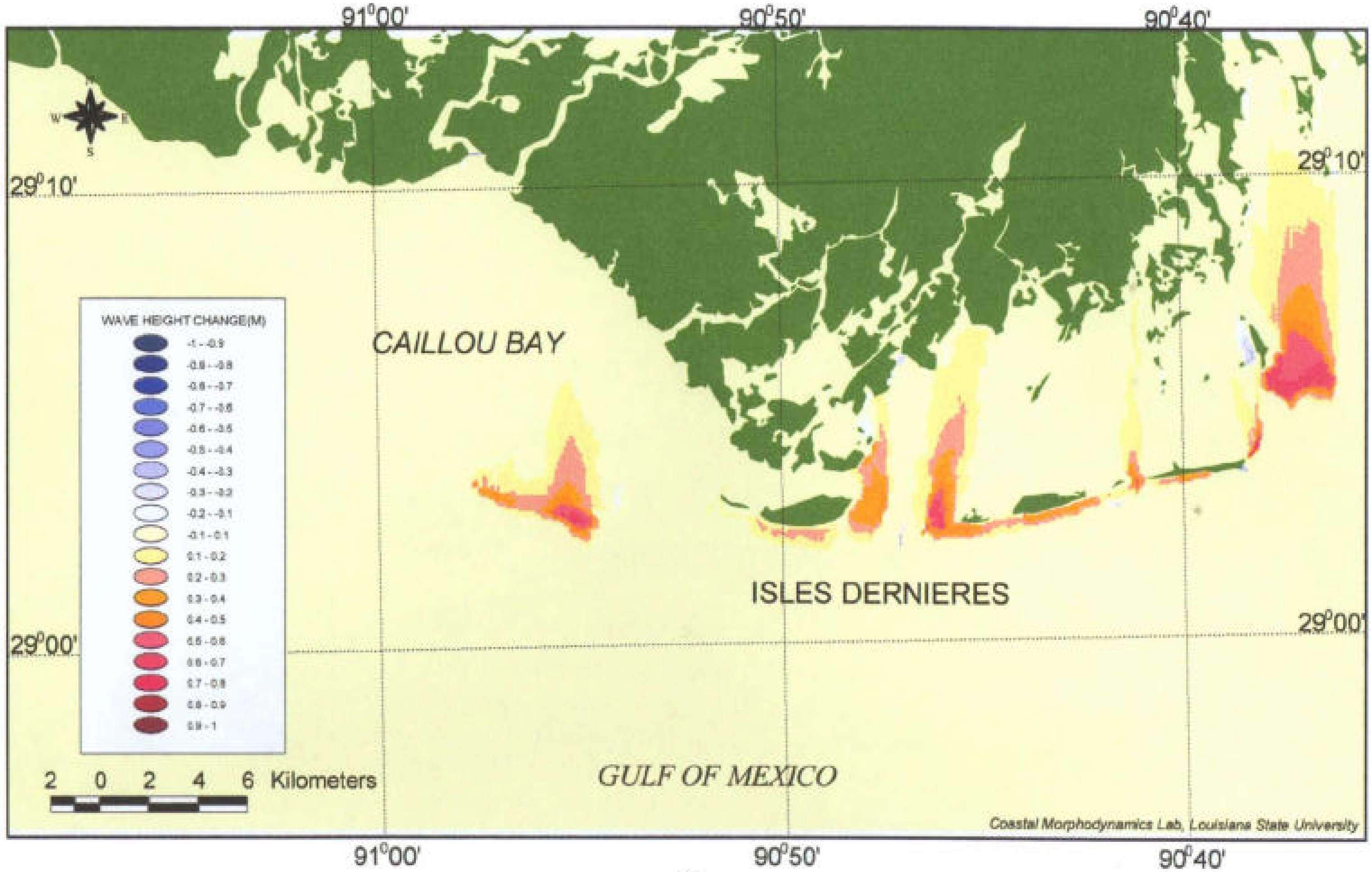


Figure 4-12. Predicted Increase in Wave Height for the 30-Year Projection in the Event of Barrier Island Erosion For Fair Weather Wave Conditions - Area 1

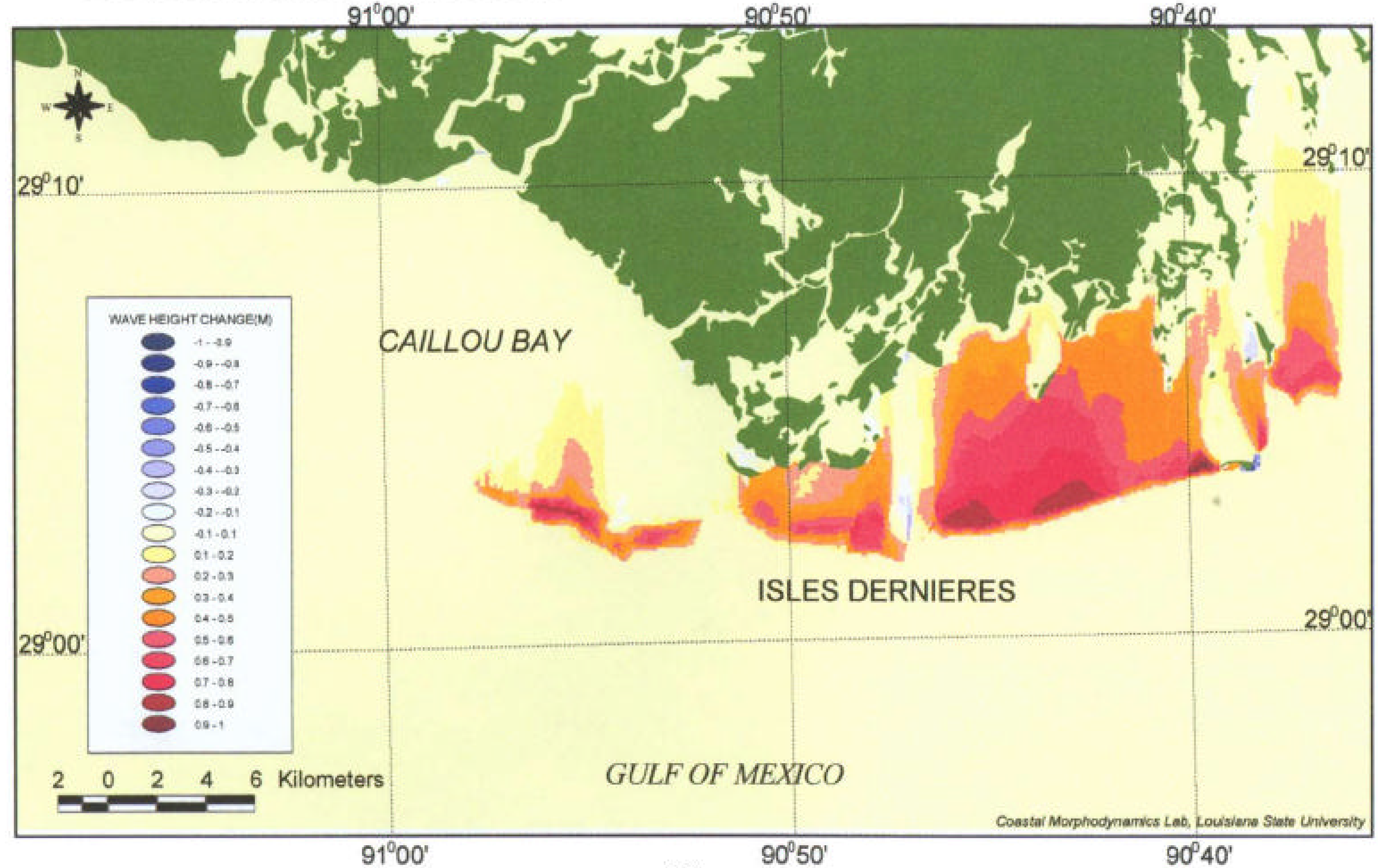


Figure 4-13. Predicted Change in Wave Height for the 30-Year Projection in the Event of Barrier Island Erosion for Fair Weather Wave Conditions - Area 2

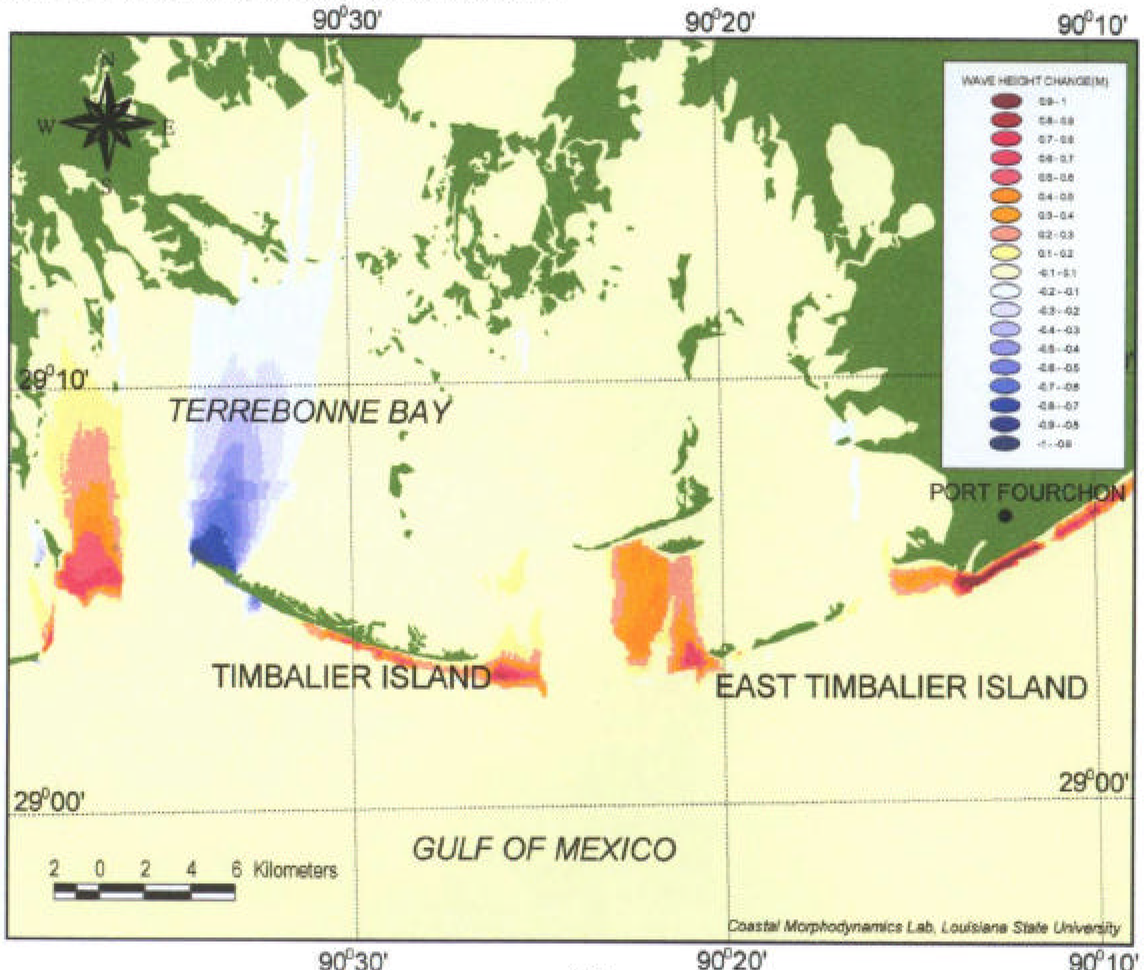


Figure 4-14. Predicted Change in Wave Height for the 100-Year Projection in the Event of Barrier Island Erosion for Fair Weather Wave Conditions - Area 2

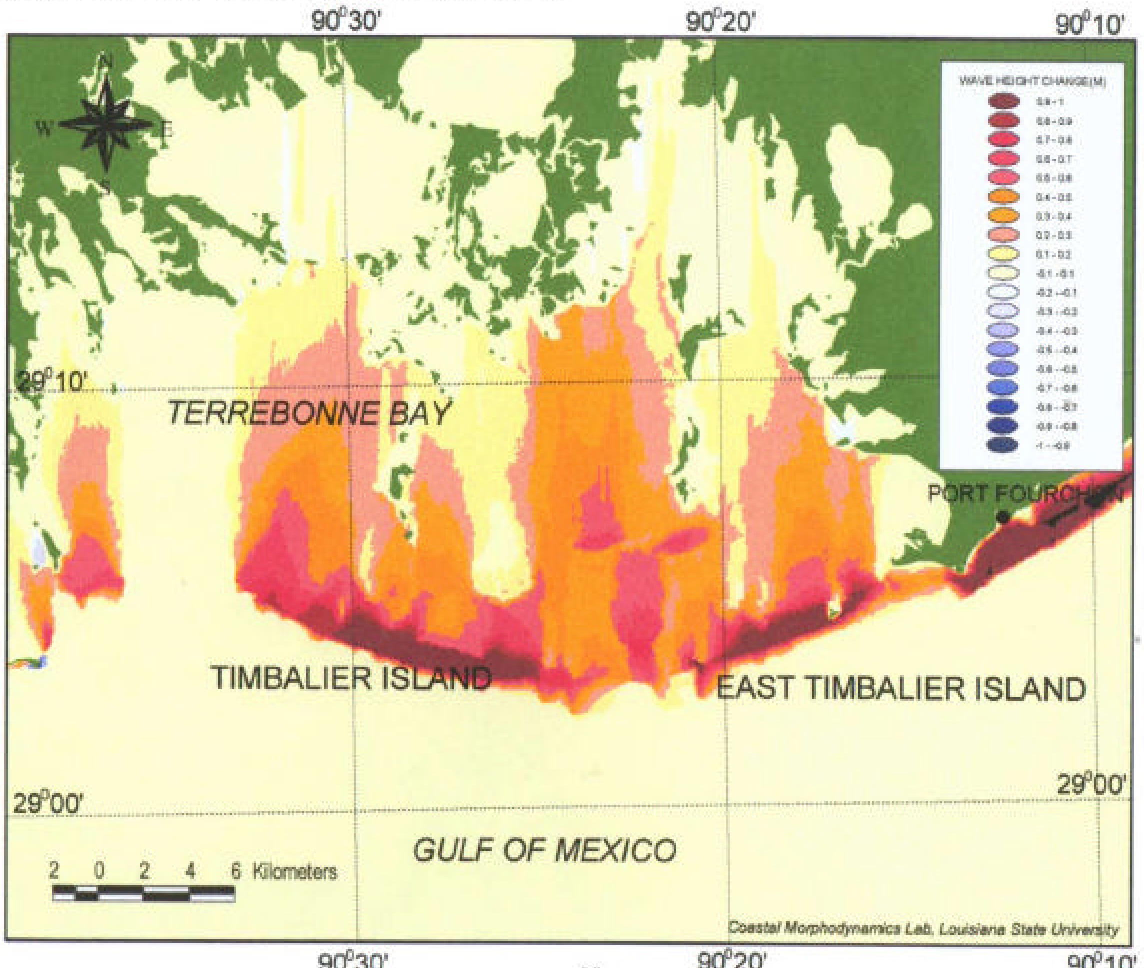


Figure 4-15. Predicted Change in Wave Height for the 30-Year Projection in the Event of Barrier Island Erosion for Fair Weather Wave Conditions - Area 3

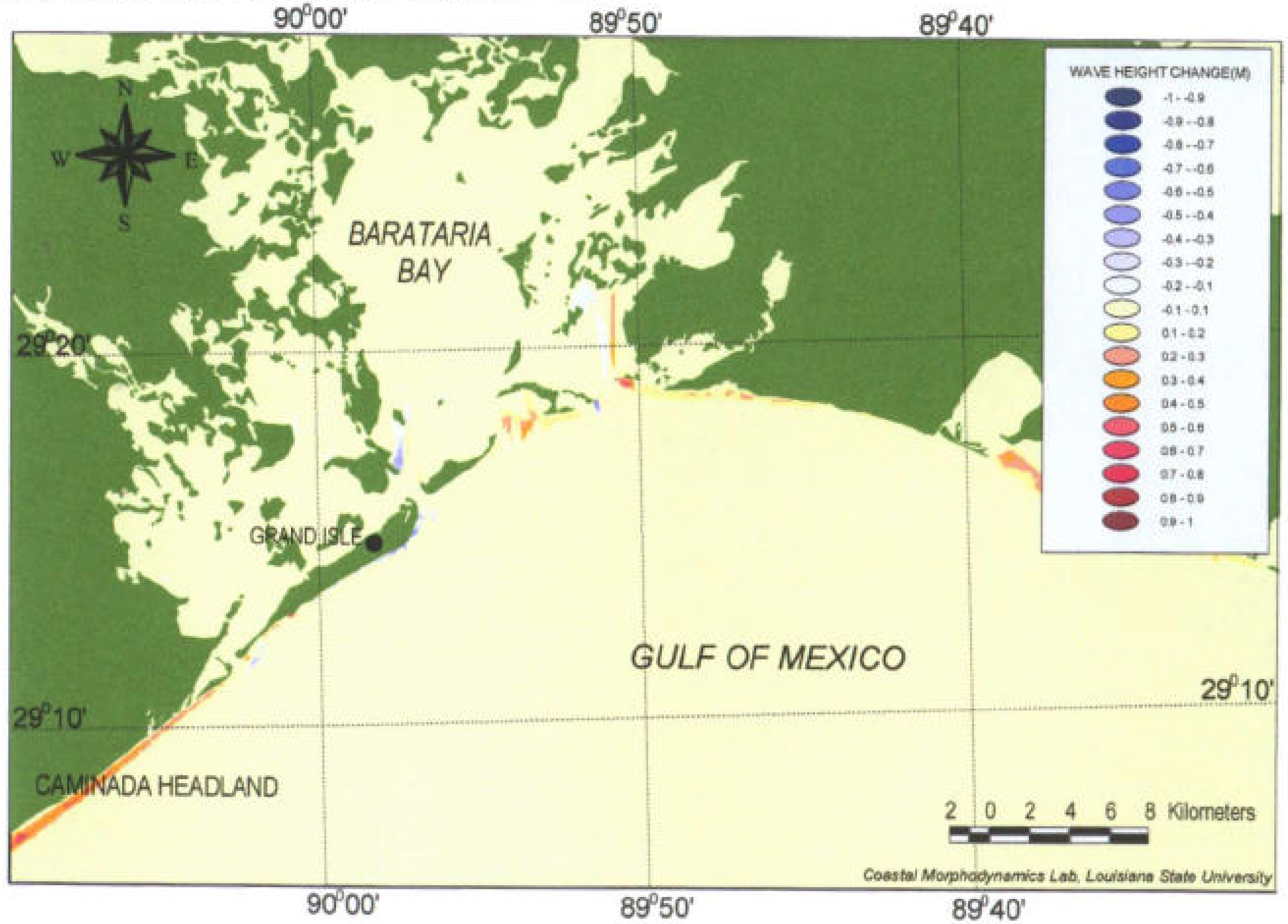
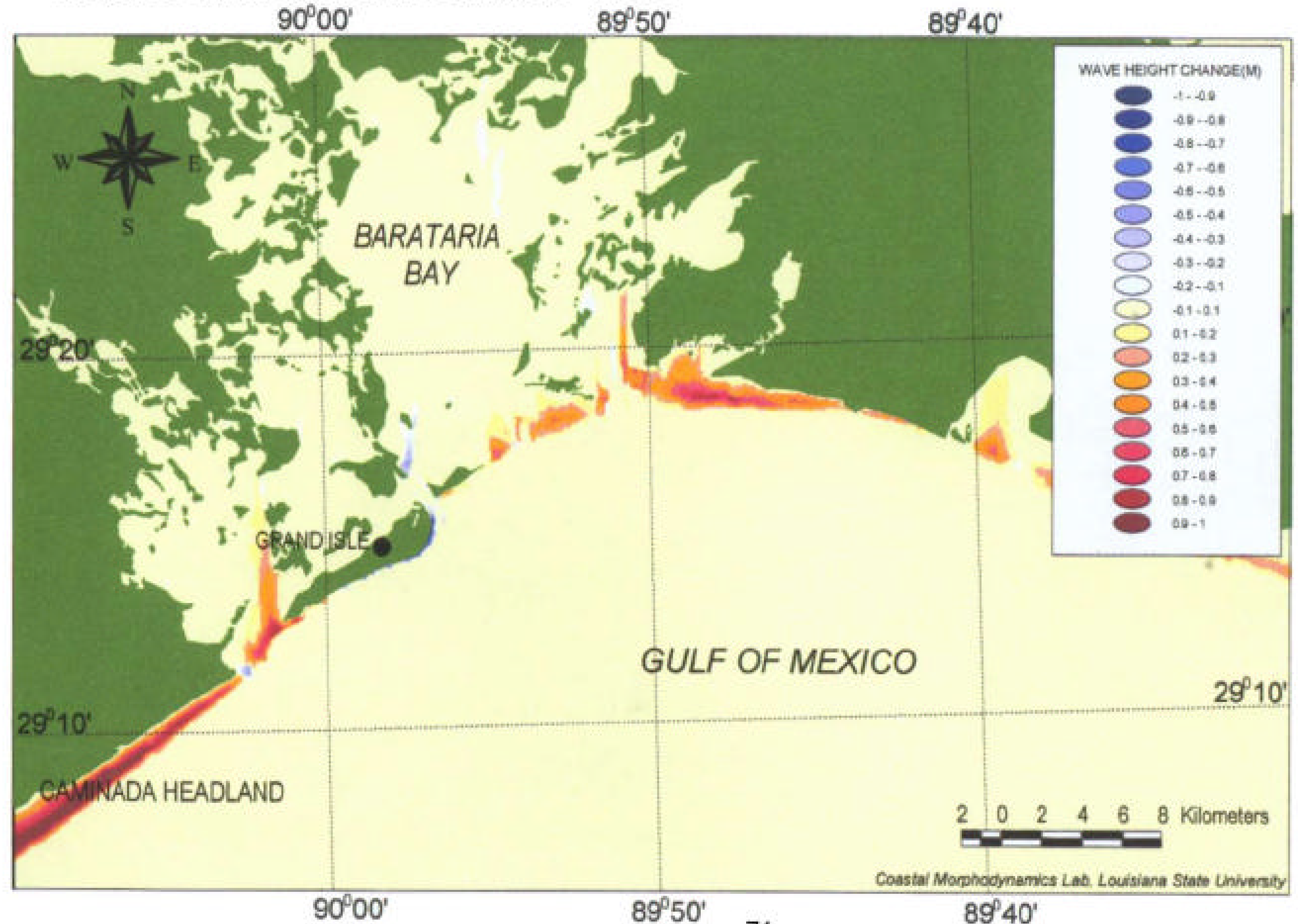


Figure 4-16. Predicted Change in Wave Height for the 100-Year Projection in the Event of Barrier Island Erosion for Fair Weather Wave Conditions - Area 3



An important point worth mentioning is that unlike areas 1 and 3, marsh shorelines in area 2 are fronted by a long fetch, up to 20-km (12.4 miles), when measured from north to south across Terrebonne Bay. Even with the present protection afforded by the barrier shoreline against swells from the Gulf, locally generated wind waves in the bay can have a detrimental impact on the marsh shoreline. As the existing barrier shoreline continues to erode, locally generated wind waves will likely increase marsh shoreline erosion.

4.2. Alternative 1

The fair-weather wave effects for Alternative 1 are shown in Figure 4-17 for the entire study area. Under fair-weather wave conditions, and wave approaches from the south, wave heights are significantly reduced in the immediate lee of the restored barriers and for considerable distances landward towards the marsh shoreline. Along the western flank of the Isles Dernieres, an approximate reduction in incident wave height of between 50 and 70% occurs due to wave energy dissipation over the shoal system seaward of Caillou Bay. In Lake Pelto, however, the limited fetch and barrier restoration combined results in considerably lower wave heights. A substantial amount of wave energy transmission through Cat Island Pass is evident and continues across the bay to the flanking marsh shoreline. Wave regeneration is apparent along the central and northern flanks of Timbalier Bay, whereas to the south and in the lee of the restored barrier islands, wave heights are minimal. As exception is at Little Pass Timbalier where wave energy transmission into the bay is apparent. Wave regeneration is clearly apparent in Barataria Bay where to the north, wave heights range between 0.3 and 0.4 meters (1.0 and 1.3 feet) under fair-weather wave conditions.

Waves that impact the marsh shoreline generally have two origins: 1) propagation into the bays from the Gulf of Mexico through breaches and tidal passes in the barrier island chains, and 2) locally generated in the bay by predominantly southerly winds. The latter requires a sizable fetch to be significant. Although the numerical modeling effort shows the significance of barrier islands in mitigating the bay's wave climate, if the fetch is long enough, wave regeneration can occur in these inland water bodies. Field investigations indicate that these waves, although low in amplitude, are steep and high in frequency. They, therefore, have a highly erosive potential along the fringing marshes. Alternative 1 also includes the use of "wave absorbers" in order to buffer these regenerated waves at the marsh shoreline. The proposed wave absorbers are composed of series of segmented structures that will be constructed parallel to the marsh shoreline as shown in Figures 4-18 and 4-19. The preliminary design of a typical structure is discussed in more detail in Step K (LADNR 1998k). The proposed wave absorber, shown in Figure 4-20, is typically 99 meters (325 feet) long at the base and 84 meters (276 feet) long at the crown. In cross-section, the absorber is approximately 10 meters (32.8 feet) wide at the base and 1.5 meters (4.9 feet) wide at the crown. The height of the absorber was determined to be approximately 3 meters (9.8 feet). The structure will absorb most of the incident wave energy and also allow sufficient water circulation through the gaps to minimize negative influences on ecological environments.

As an example of wave regeneration and the dampening effects of the wave absorbers, two profiles are presented in Figures 4-21 and 4-22. They represent two locations in Timbalier Bay with varying fetch lengths, 6 km and 13 km (3.7 and 8.1 miles). In both simulations, the offshore deep-water boundary conditions include a significant wave height of 6 meters (19.7 feet) and wind speed of 20-m/sec (45 m.p.h.) with both directions being from south to north. Total wave energy dissipation occurs at the seaward flank of the barrier; however, prolonged wind stress on the water surface in the bay generates waves of between 0.15 and 0.20 meters (0.49 and 0.66 feet). With the wind forcing, the waves are 0.05 to 0.07 meters (0.16 to 0.23 feet) higher than without the wind forcing component, increase the wave height by 50 to 70% for this specific case. Low input waves of 0.10 meters (0.33 feet) high were used in this simulation to realistically reproduce wave conditions in the back-barrier bays. Wave height increases toward the shoreline due to the increased fetch. Thereby, wave regeneration and growth during propagation across the bays will likely induce erosion of the fringing marshes, with even more energy being transmitted during stronger southerly winds.

Figure 4-17. Wave Heights for Alternative 1 Scenario During Fair Weather Conditions

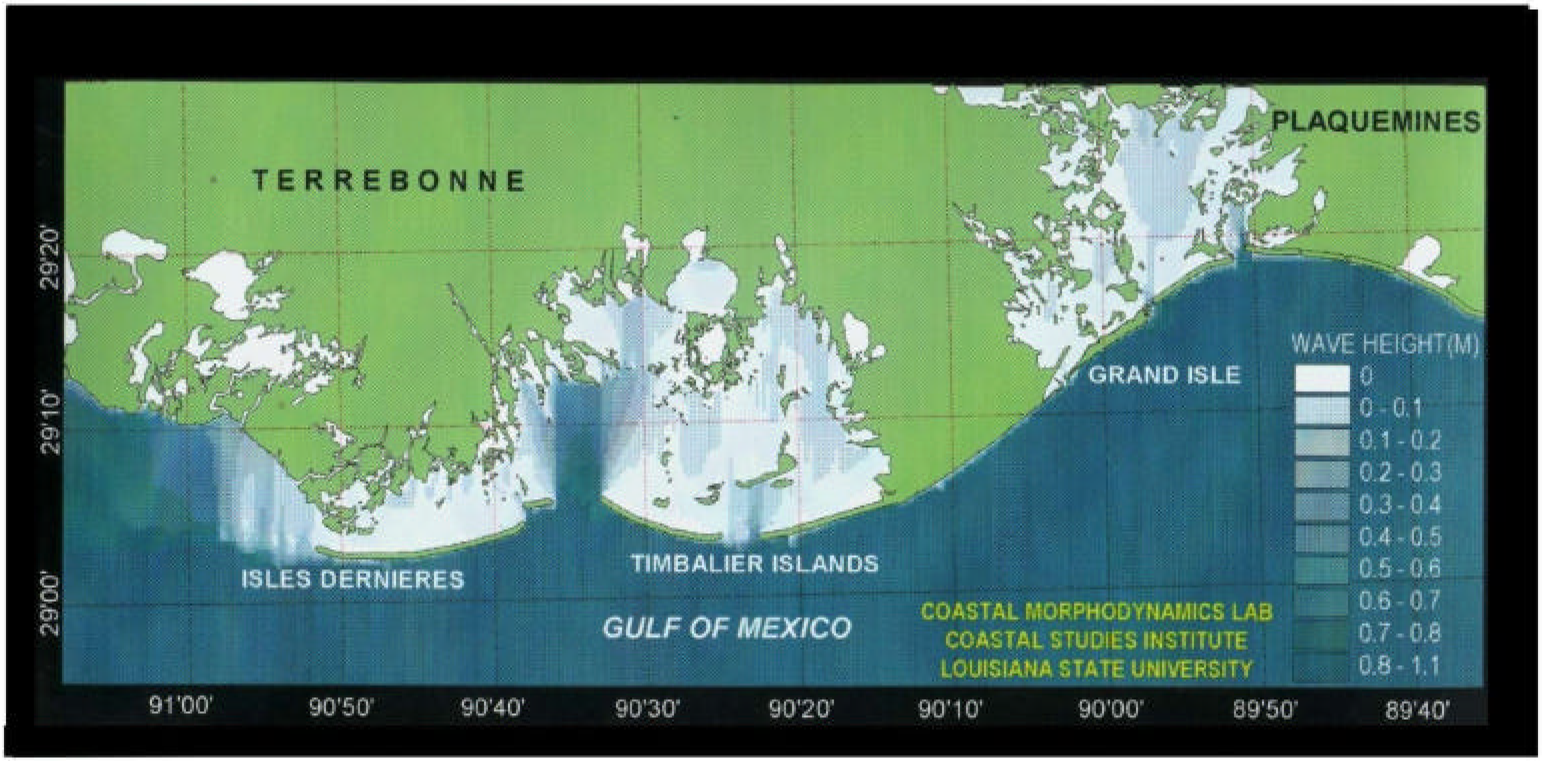
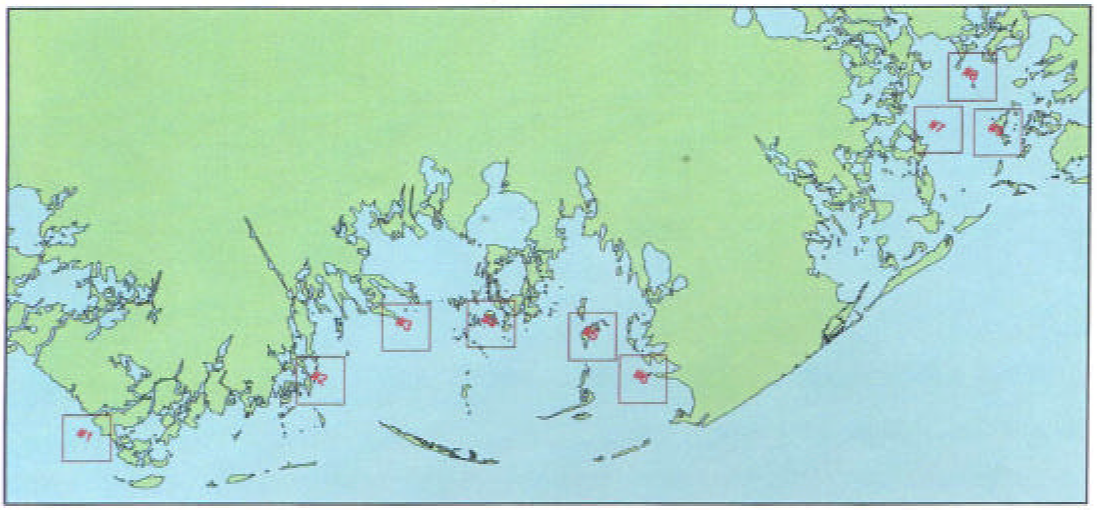
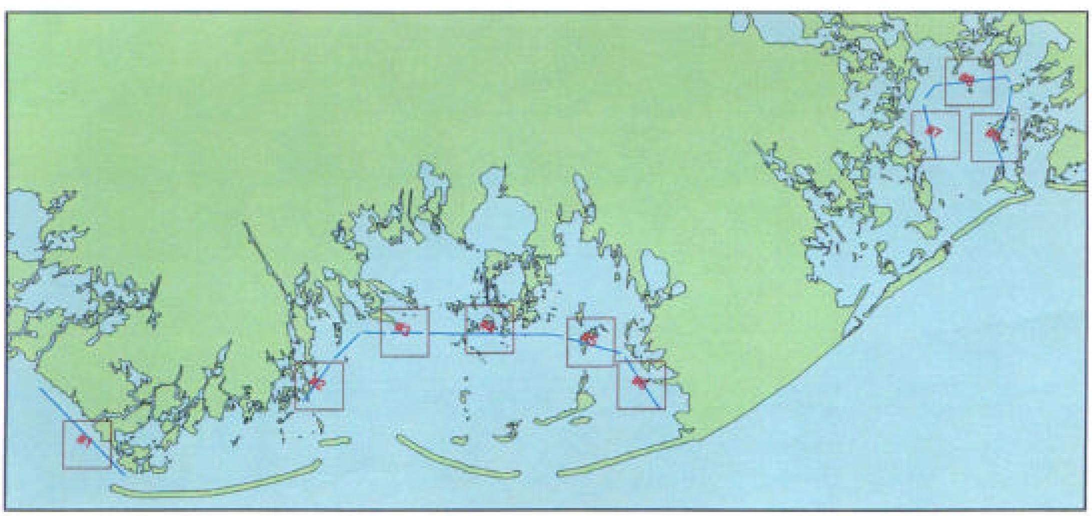


Figure 4-18.

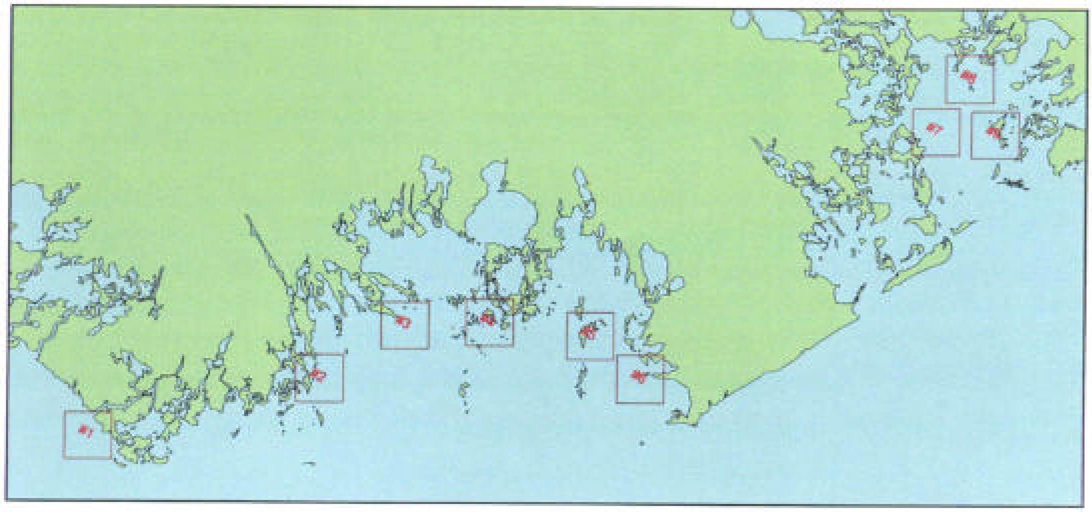


Index map for 30-Year No-action

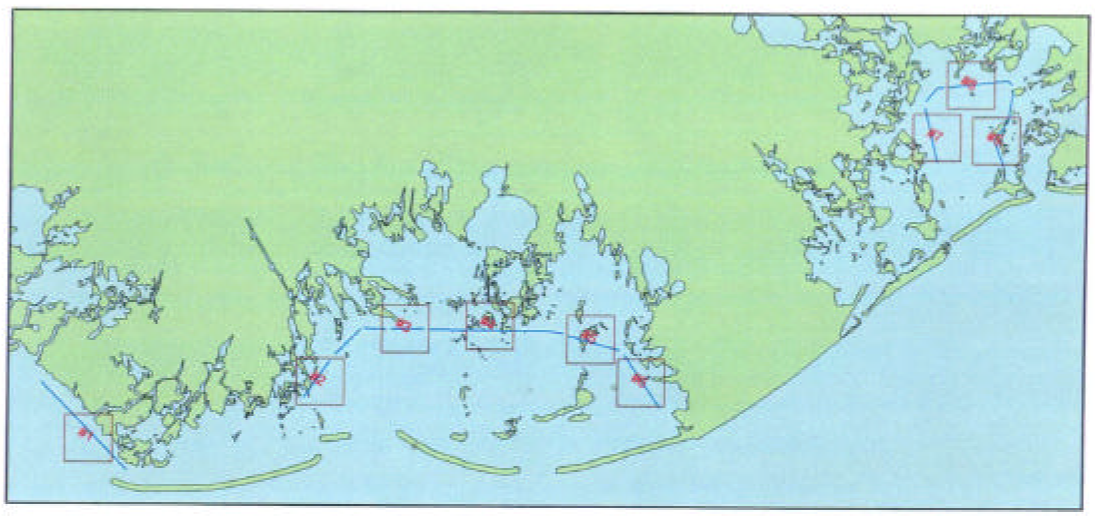


Index map for alternative 1

Figure 4-19.



Index map for 100-Year No-action



Index map for alternative 1

Figure 4-20.

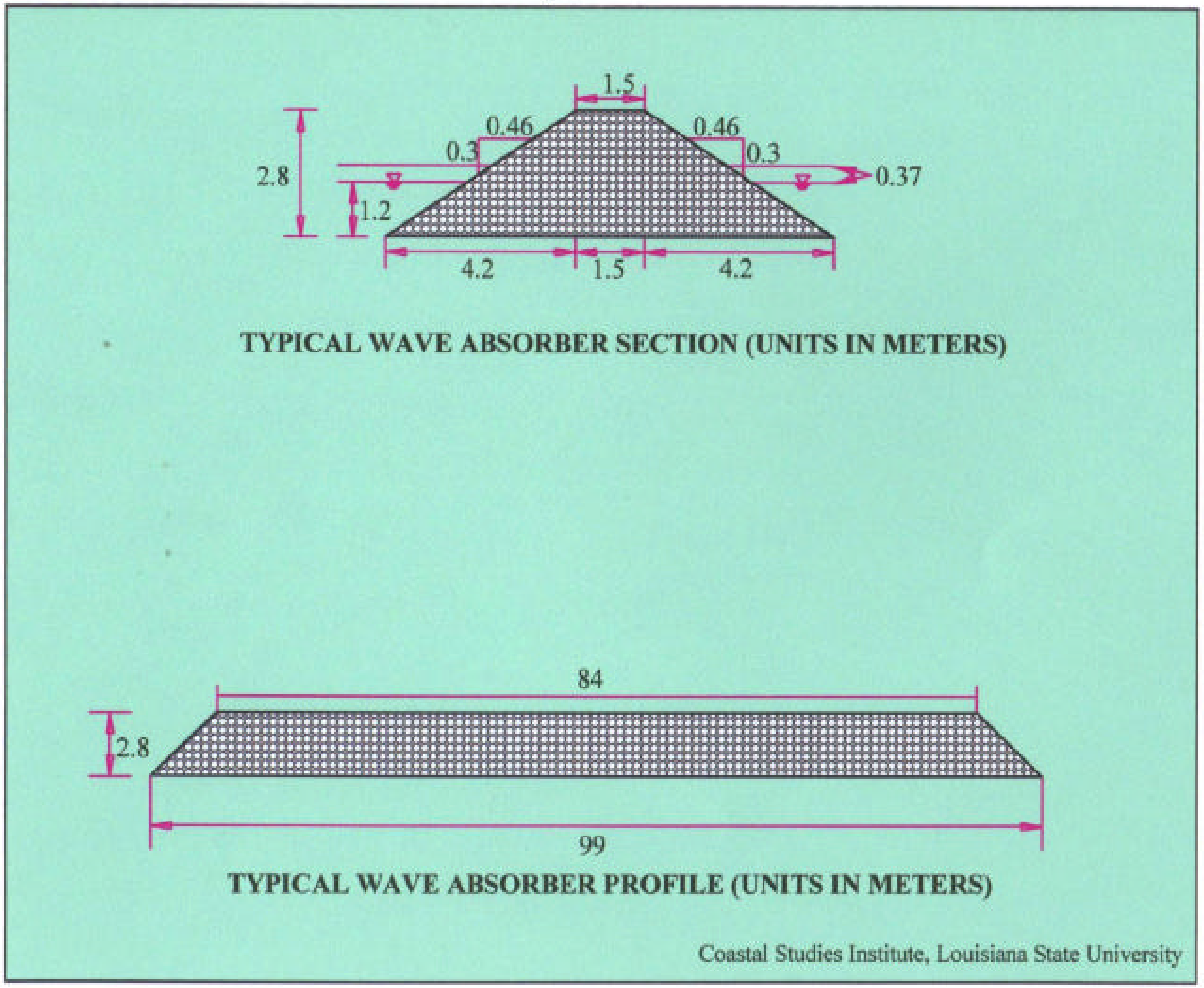

1.5
0.46
0.46
0.3
0.3
2.8
1.2
0.37
4.2
1.5
4.2
TYPICAL WAVE ABSORBER SECTION (UNITS IN METERS)
84
2.8
99
TYPICAL WAVE ABSORBER PROFILE (UNITS IN METERS)
Coastal Studies Institute, Louisiana State University

Figure 4-21. Alternative 1 Wave Simulation - 6 km Fetch

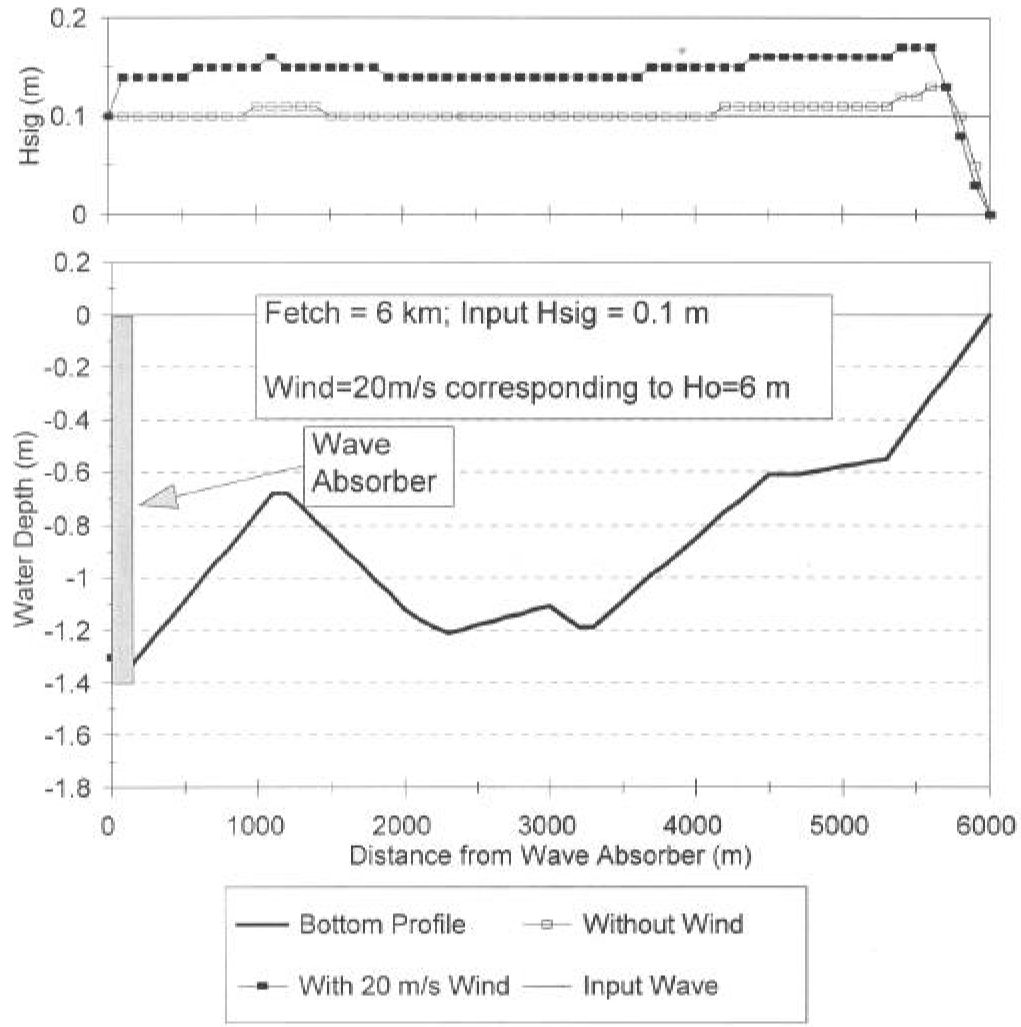
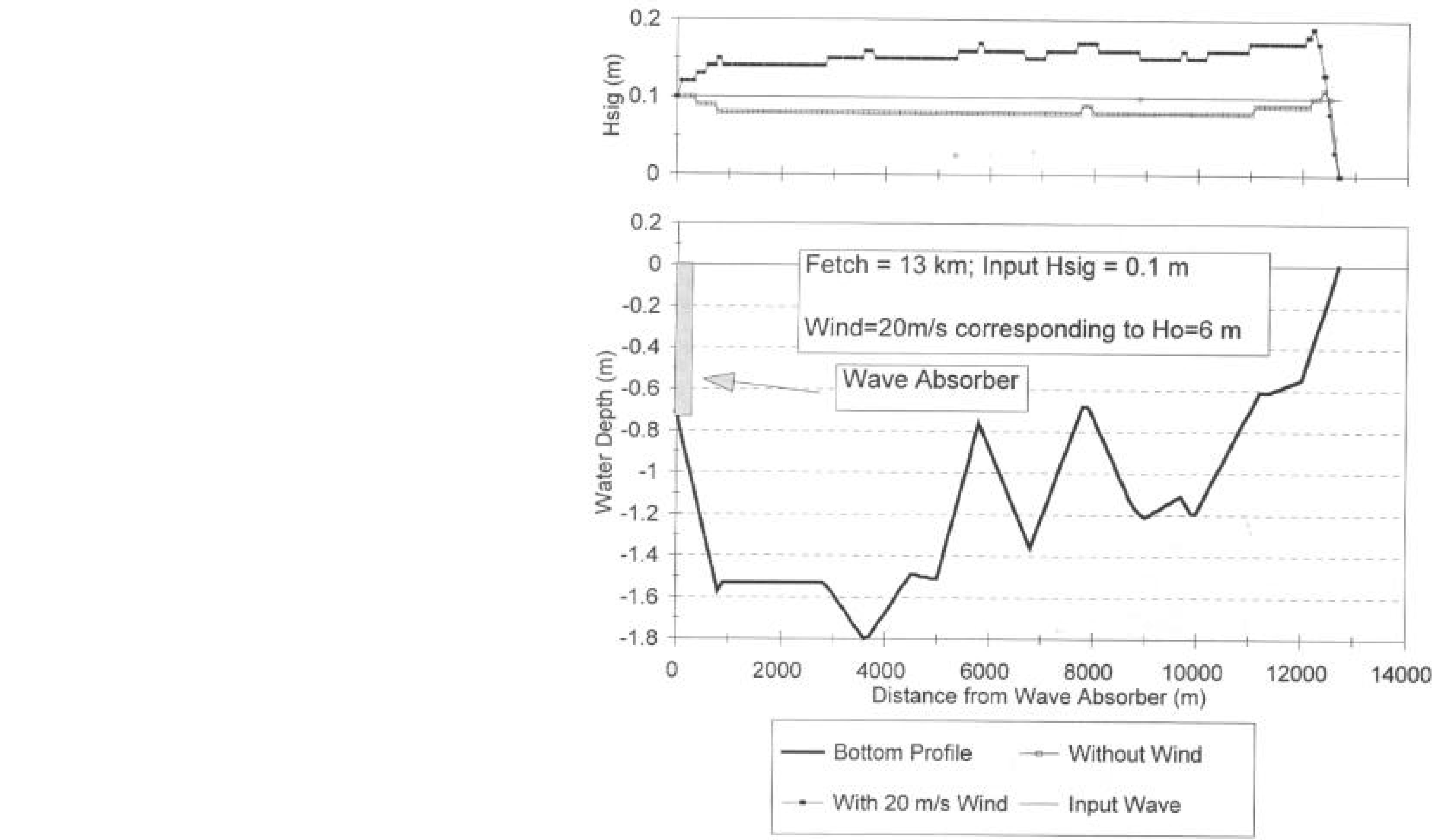


Figure 4-22. Alternative 1 Wave Simulation - 13 km Fetch



Due to the fine scale of the modeling effort involving the wave energy absorbers, a series of very fine grids of 10 meters x 10 meters (33 feet x 33 feet) were established. The previously used 400 meters x 400 meters (1,300 feet x 1,300 feet) grids previously used were not capable of resolving the computations needed for the fine-scale to test the absorbers. Nine locations, (Figures 4-18 and 4-19), were chosen for fine-scale modeling: one in Area 1 (Caillou Bay), five in Area 2 (Terrebonne Bay) and three in Area 3 (Barataria Bay). The calculated wave conditions from the larger scale fair-weather wave modeling on the computational grid with dimensions of 400 meters x 400 meters (1,300 feet x 1,300 feet) were used as input to the fine scale wave absorber grids.

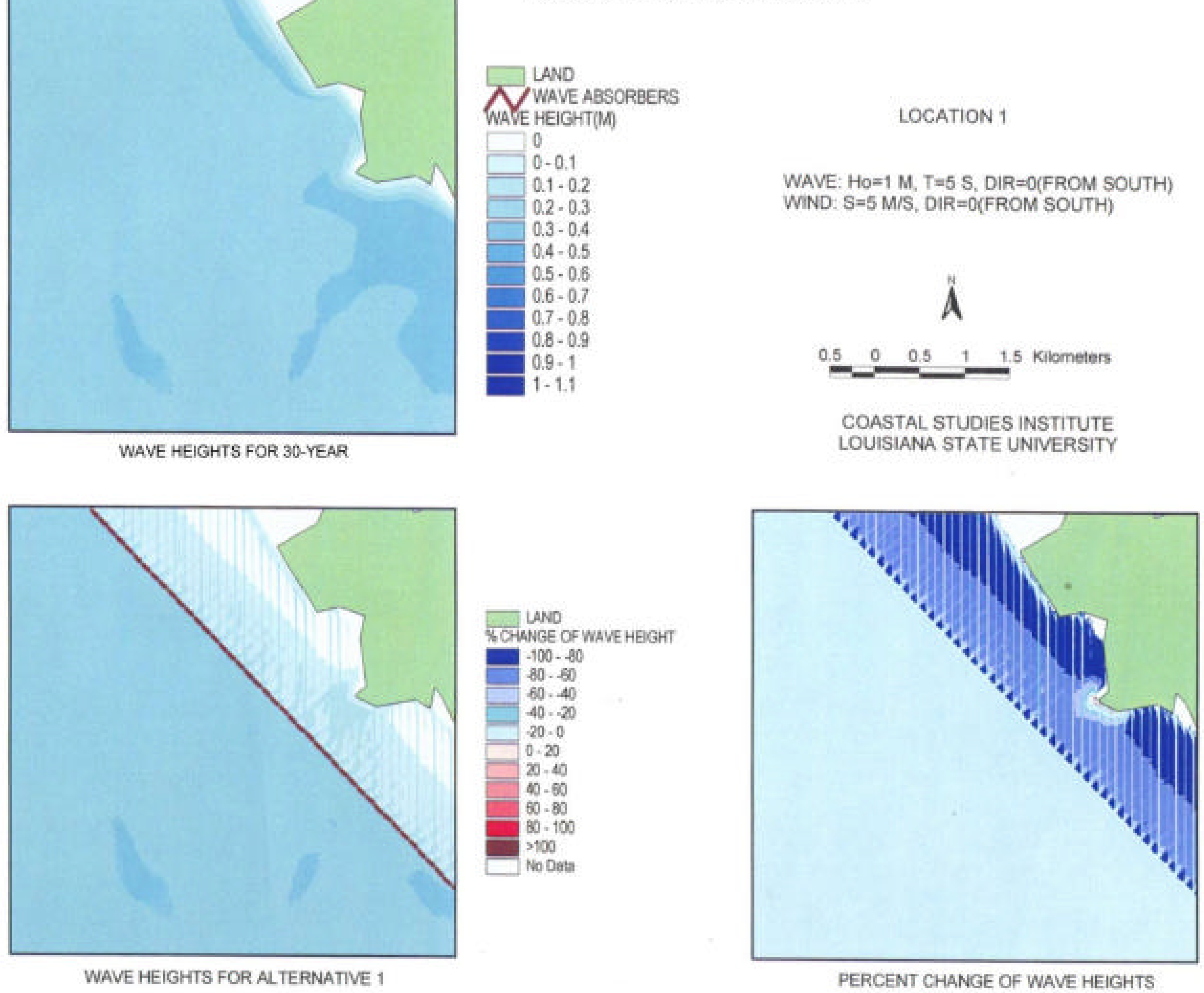
Over half of the wave height was reduced in the lee of the wave absorbers compared to no-action. In all locations, the implementation of Alternative 1 reduced wave heights at the marsh shoreline by greater than 60%. Figures 4-23 to 4-28 are examples of the wave height reduction associated with Alternative 1 along the marsh shoreline. Table 4.1 summarizes the wave reduction benefits provided at the marsh shoreline due to Alternative 1.

Table 4.1. Alternative 1 Reduction in Wave Height.

Wave Absorber Location	Percent Wave Height Reduction Compared to No-Action
1	>80%
2	80-100%
3	60-100%
4	60-100%
5	60-100%
6	80-100%
7	80-100%
8	80-100%
9	80-100%

It is important to note the design and use of these wave-absorbing devices lends itself to low energy, bay environments as discussed in the Step K report (LADNR 1998k). Construction of these structures without barrier island restoration (or a structural alternative) would permit wave energy levels in the bays to increase as demonstrated throughout the wave forecasting for the 30 and 100-year projections. This will result in a transition from low energy protected water bodies to higher energy coastal embayments. The exception is in Barataria Bay.

Figure 4-23. Simulated Wave Heights During Fair Weather Conditions
Alternative 1 and 30-Year Scenario



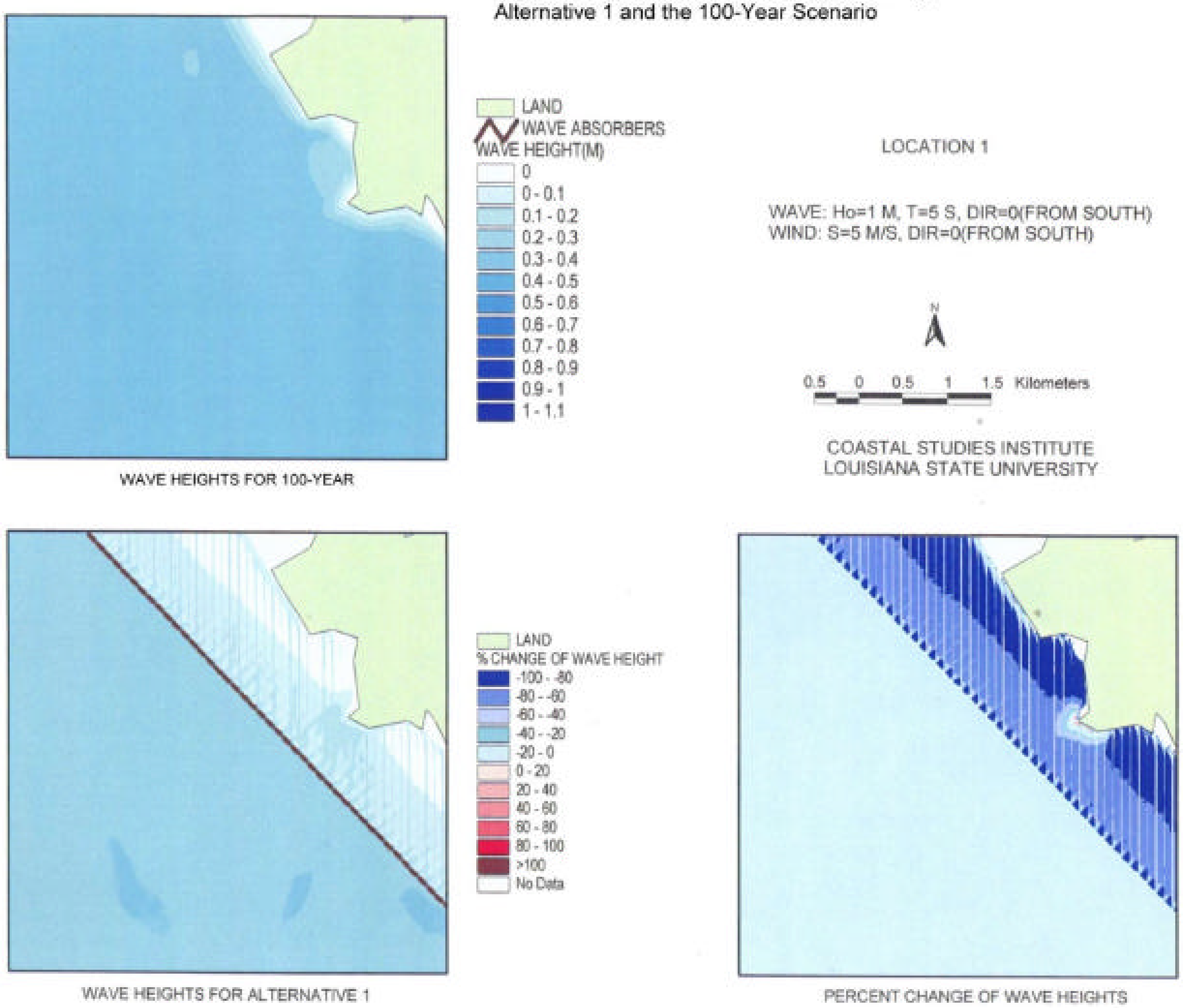
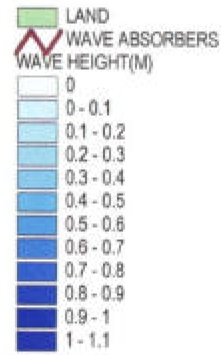


Figure 4-24. Simulated Wave Heights During Fair Weather Conditions for Alternative 1 and the 100-Year Scenario

Figure 4-25. Simulated Wave Heights During Fair Weather Conditions for Alternative 1 and 30-Year Scenario

WAVE HEIGHTS FOR 30-YEAR



LOCATION 3

WAVE: Ho=1 M, T=5 S, DIR=0(FROM SOUTH)
WIND: S=5 M/S, DIR=0(FROM SOUTH)

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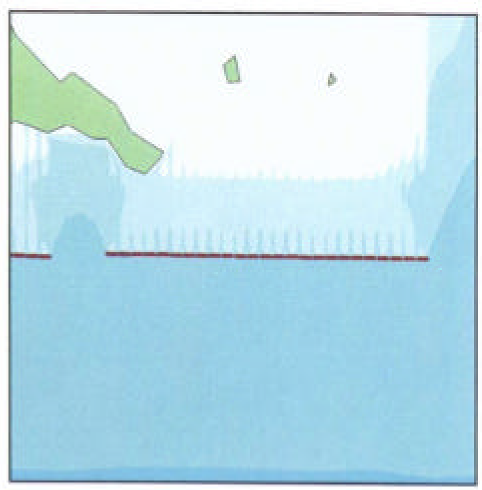
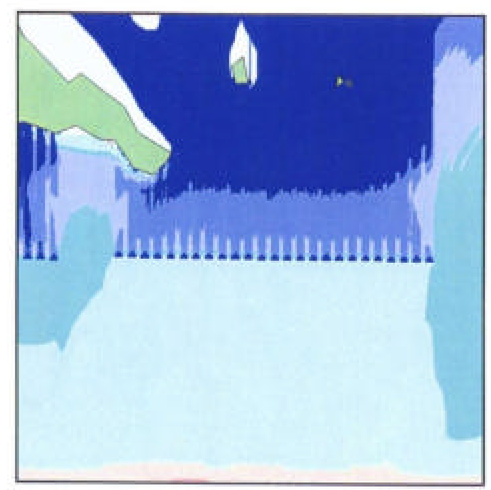


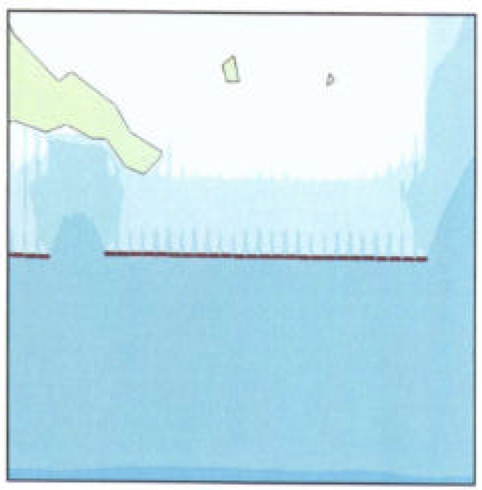
WAVE HEIGHTS FOR ALTERNATIVE 1



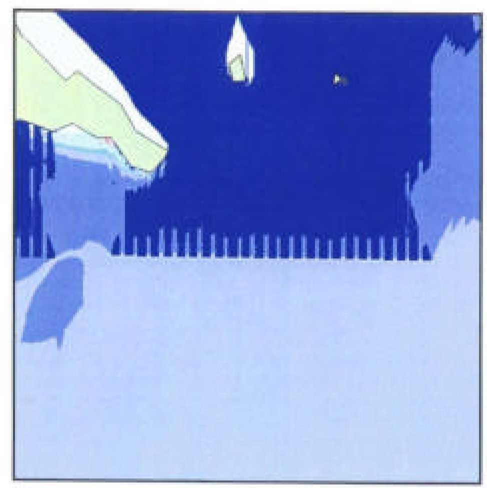
PERCENT CHANGE OF WAVE HEIGHTS

Figure 4-26. Simulated Wave Heights During Fair Weather Conditions for Alternative 1 and 100-Year Scenario

WAVE HEIGHTS FOR 100-YEAR



WAVE HEIGHTS FOR ALTERNATIVE 1



PERCENT CHANGE OF WAVE HEIGHTS

Figure 4-27. Simulated Wave Heights During Fair Weather Conditions for Alternative 1 and 30-Year Scenario

WAVE HEIGHTS FOR 30-YEAR

LAND
WAVE ABSORBERS
WAVE HEIGHT(M)
0
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1
1 - 1.1

LOCATION 8

WAVE: Ho=1 M, T=5 S, DIR=0(FROM SOUTH)
WIND: S=5 M/S, DIR=0(FROM SOUTH)

N

0.5 0 0.5 1 1.5 Kilometers

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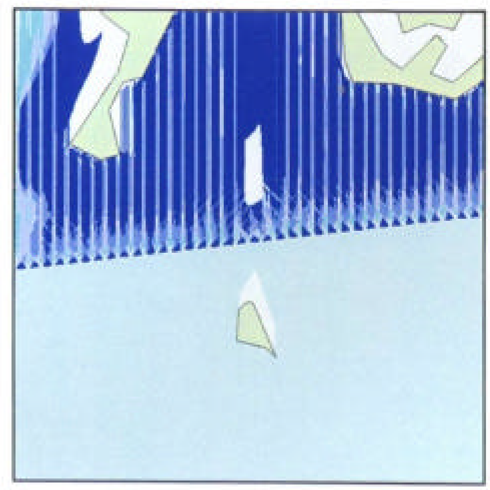
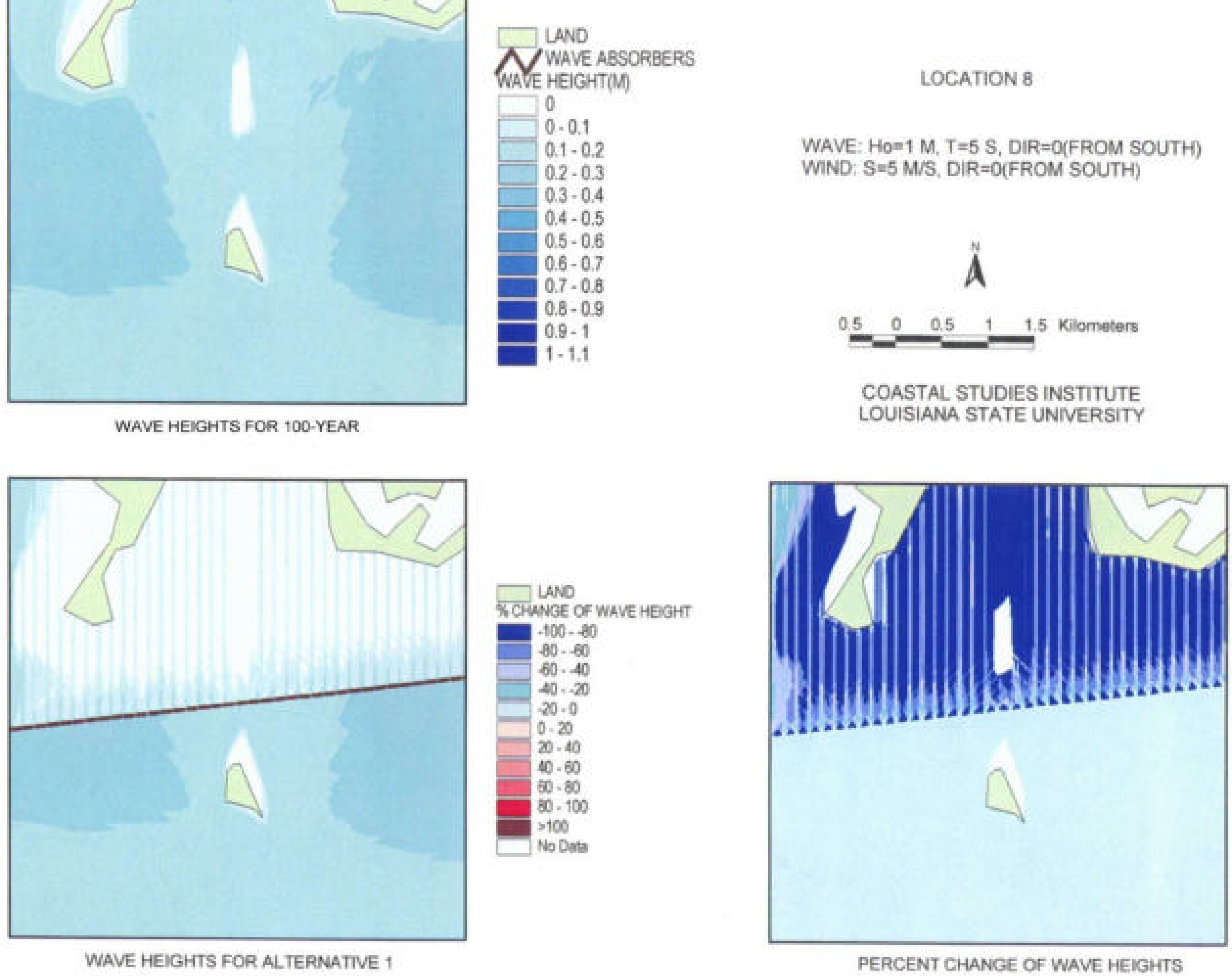
WAVE HEIGHTS FOR ALTERNATIVE 1

LAND
% CHANGE OF WAVE HEIGHT
-100 - -80
-80 - -60
-60 - -40
-40 - -20
-20 - 0
0 - 20
20 - 40
40 - 60
60 - 80
80 - 100
>100
No Data



PERCENT CHANGE OF WAVE HEIGHTS

Figure 4-28. Simulated Wave Heights During Fair Weather Conditions for Alternative 1 and 100-Year Scenario



4.3. Alternative 2

Alternative 2 controls wave-energy in the back-barrier bay and marsh shoreline by reducing wave energy transmission from the Gulf through the gaps between the barrier islands. Alternative 2 includes closure of several gaps in the barrier chain as described in detail previously. Numerical wave modeling indicates that wave heights were effectively reduced due to closure of some of the gaps as shown in Figures 4-29 to 4-31.

As expected, the wave energy reduction is most significant in the vicinity of and landward of the previous location of breaches or tidal inlets. By closing the gap currently occupied by Coupe Colin between Raccoon Island and Whiskey Island, substantial wave-height reduction was predicted in Caillou Bay, Area 1 (Figure 4-29). Under this alternative, waves in the bays do not exceed 0.1 to 0.2 meters (0.33 to 0.66 feet). The exception is Whiskey Pass where waves propagating into Lake Pelto are 0.4 meters (1.3 feet) in height. The wave heights along the Lake Pelto shoreline experience a reduction of 21% when comparing Alternative 2 to no-action in 30-years and 63% in 100-years.

The effects of Alternative 2 for Area 2 are most apparent landward of the eastern tip of East Timbalier Island and the adjacent Port Fourchon Coast. As shown in Figure 4-6, during fair-weather conditions, waves typically exceed 0.4 meters (1.3 feet) in Timbalier Bay during the 30-year no-action forecasts. They increase to 0.8 m during the 100-year no-action forecast as shown in Figure 4-7. The exception is north of Cat Island Pass. Here, waves up to 0.8 meters (2.6 feet) in height were projected adjacent to the marsh shoreline for present-day conditions. Implementing Alternative 2 will result in an average wave height between 0.1 and 0.2 meters (0.33 to 0.66 feet). Overall, the reduction in wave heights along the bay shoreline was minimal in 30-years compared to no-action, but the wave heights were reduced by 30-50% compared to no-action in 100 years.

The influence of Alternative 2 is minimal for Area 3. This is due to the limited wave energy transmission through the tidal passes and inlets under the current configuration. Wave height reduction of approximately 20 to 30% is apparent in Barataria Bay. The present-day and no-action forecasts indicate no substantial change in wave heights in the Bay where the maximum fair-weather wave height is 0.4 meters (1.3 feet). Alternative 2 results in reducing the maximum wave height to an average between 0.1 and 0.2 meters (0.33 to 0.66 feet). Along the bay shoreline Alternative 2 only reduces wave heights by less than 10% compared to 30- and 100-year no-action projections in Area 3.

Figure 4-29. Predicted Wave Height for Alternative 2 Configuration During Fair Weather Conditions Area 1

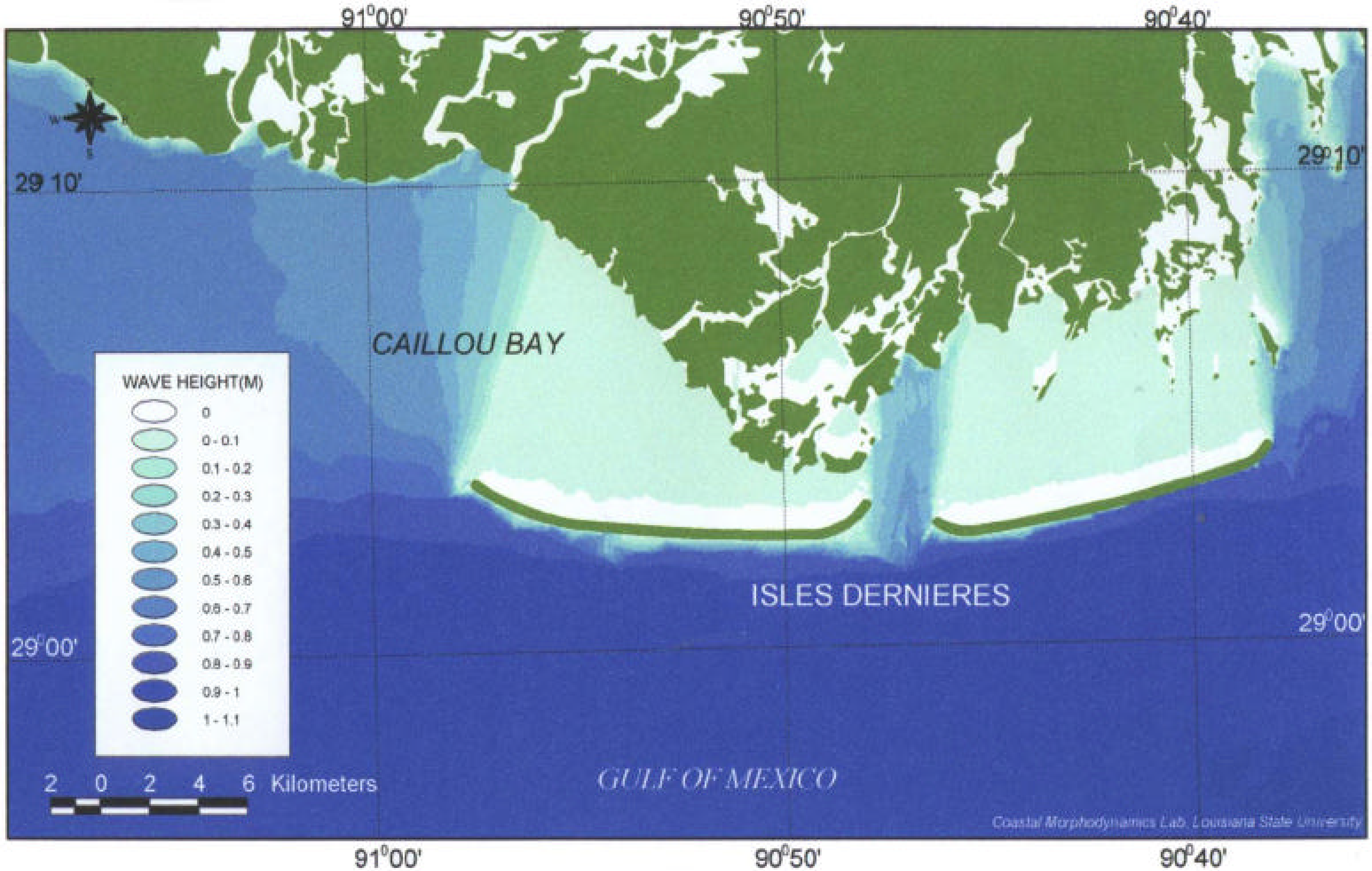


Figure 4-30. Predicted Wave Height for Alternative 2 Configuration During Fair Weather Conditions Area 2

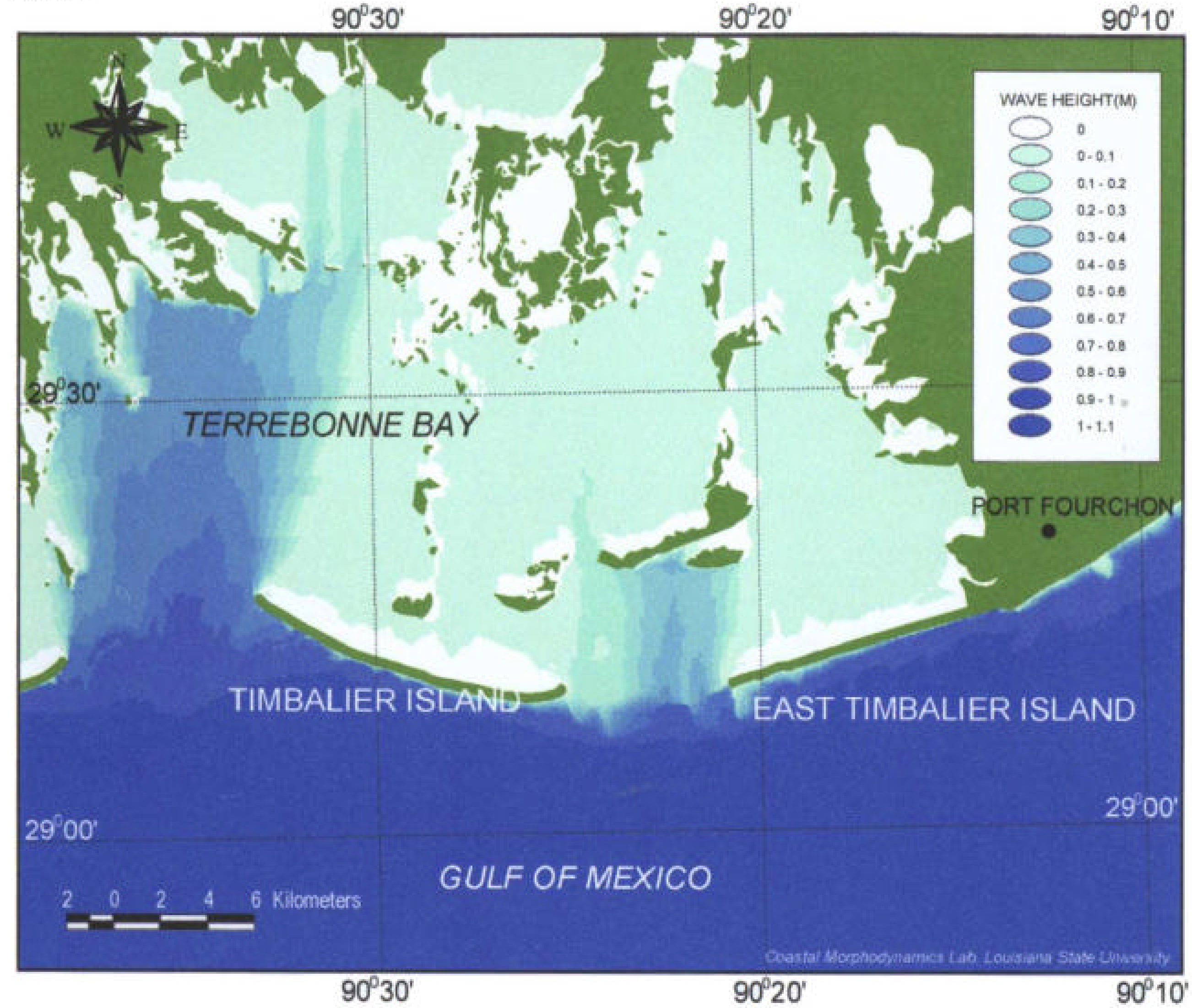


Figure 4-31. Predicted Wave Height for Alternative 2 Configuration During Fair Weather Conditions Area 3